ANDRÉ-THOMAS

Nobody knows his birth-date. Not only has he obviously discovered the secret of eternal youth but he wants to keep it for himself. Suffice it to say that he was probably just over thirty in 1897, when he wrote his remarkable thesis on the cerebellum. This was already typical of the breadth of his approach, for this comprehensive study is at once anatomical, physiological and clinical.

In 1910 he writes, with DEJERINE, his first book, on *"Diseases of the Spinal Cord"*, one of the best monographs ever written. Soon after, he comes back to his "premières amours" with *"Cerebellar Function"* (1911); *"Cerebellar Localisations"* (1914); *"Injuries of the Cerebellum"* (1918); *"The Cerebellar Abscesses"* (1935); and *"The Cerebellar Heredo-Atrophies"* (1939).

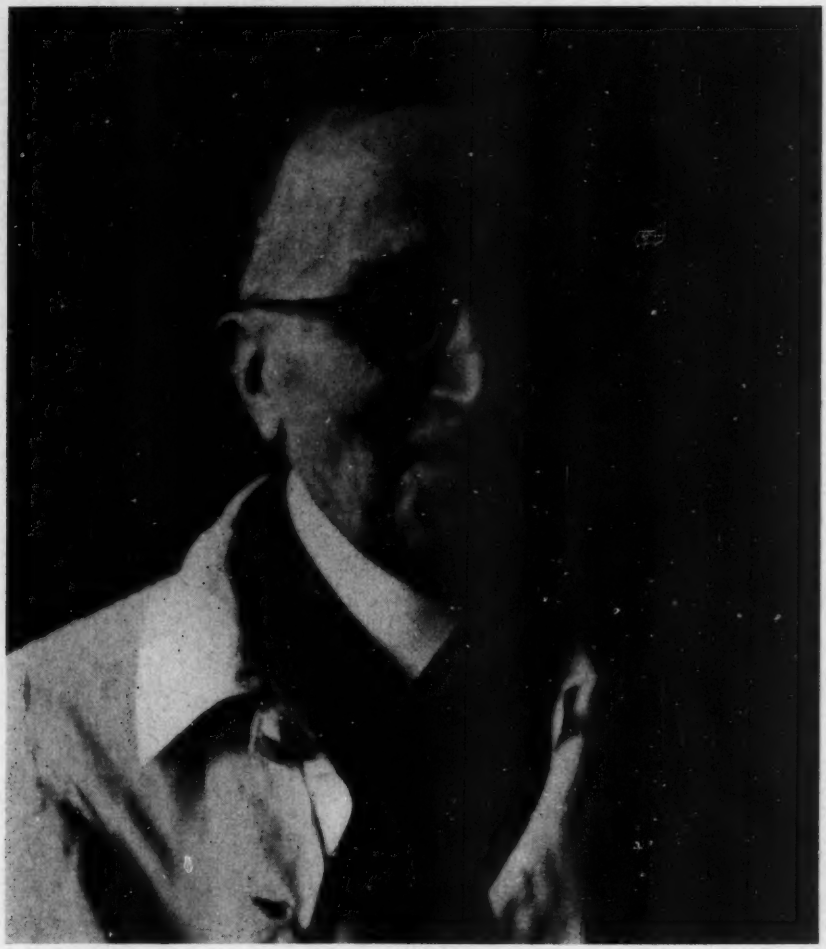
In 1923 he studies the *"Nervous and Circulatory Disorders Caused by Cervical Ribs"*, and in 1926 the *"Methods of Investigation of the Sympathetic System and their Value"*.

In the 'forties, a new series of works is initiated—*"Equilibrium and Equilibration"* (1940); *Body Axis, its Musculature and Innervation"*, in collaboration with DE AJURIAGUERRA (1948); and *"A study of the Signs of Muscle Tone"*, again in collaboration with DE AJURIAGUERRA (1949).

To an unprejudiced mind, this would seem a decent contribution to neurology, specially if one takes into account that we have only quoted the "têtes de chapitres". But this "diable d'homme" in his late seventies becomes interested in anencephalics, and suddenly the question arises in his mind: "But what is the neurological behaviour of the normal infant?" And from this point starts a fascinating series of studies on the newborn, culminating with the well-known *"Neurological Studies of the New-Born and the Young Infant"* (1952), written in collaboration with Madame SAINT-ANNE DARGASSIES, his worthy pupil, follower and spiritual heir. In 1953 he compares (with Mlle. AUTGAERDEN) the two gaits, the newborn's and the definitive one; in 1954, with CHESNI, he is concerned with the hand of the young infant. And, finally, in 1959, he writes, again with Mlle. AUTGAERDEN, a charming booklet on *"Psycho-emotional Life of the Young Infant"*. Shall we mention, finally, that in 1912 he devoted a book to psychotherapy?

Such is ANDRE-THOMAS, of neurology both the LEONARDO and the TITIAN.

CYRILLE KOUPERNIK.



ANDRE-THOMAS

From a photograph at the National Hospital, Queen Square, London.

Copies of this portrait can be obtained from the Editor.

INTEGRATION IN THE INFANT

ANDRE-THOMAS
Member of the National Academy of Medicine, Paris.

From conception onwards, the acquisition of new structures and new capabilities is constantly changing the infant into new, different organisms. The way in which new functions are introduced or appear in the organism is "Integration". To this problem, André-Thomas has here applied his lively inquiring mind, looking at the motor and visual aspects and the contributions of conditioning and the affection between infant and mother.

Hitherto, the term "integration" has lacked any precise or agreed definition.

Integration was the subject of an interesting discussion directed by Professor Alajouanine in his department at the Salpetrière in October, 1958, I was unable to be present, but I understand that the term "Integration" remained without any precise or agreed definition. As the dictionary shows, it conveys different meanings to neurologists, psychologists, biologists, physiologists and mathematicians.

I look on integration as the introduction of a function into the intimacy of a living organism—an introduction so deep and so intimate that the function introduced becomes part of this organism, and in a way makes it a new organism. Integration is not definitive and is not exempt from modification, attenuation or perfecting; it must be considered in time and in evolution, and this seems especially true in the first few years, and above all in the first few months, of life.

The integrations of this first period have particularly attracted our attention because they are few and some are fundamental, so they are easily observed in a normal infant directly they appear in time and space. The appearance of a new function in an organism, and its definitive integration, may seem simple but is in fact a complex phenomenon, if one takes into account the continually changing structure of the central nervous system and the properties of the function being incorporated.

Integration takes place constantly throughout life, and in that way is a persistent phenomenon. The functions which establish themselves are open to transformation, and thus the individual's personality is open to modification. Some integrations are indispensable — e.g., breathing, which begins at birth in the transition from intrauterine life to life in the air. Breathing is not the first integration, for it appears several months later than the functioning of the foetal heart, which maintains the circulation and through it nutrition, development, growth and oxygenation of the foetus during intrauterine life.

Breathing and circulation are two fundamental and definitive integrations which harmonize together from birth. At birth nutrition begins in a new way, the necessary materials now being provided by the mother in a very different form. This new

Note: This article was translated from the French by Mrs. J. M. Hillelson, B.Sc., O.T.R.

way is progressively modified and the food varies with the child's growth and development.

The essential elements — circulation, respiration, alimentation and nutrition— represent vegetative life whose end is metabolic and physiochemical, but the initiation of function depends on physiomechanical processes.

Origins of Motor Activity

These physiomechanical processes are much more obvious in regard to the development of articulatory growth, of which the first outlines are already apparent in the 4½-months foetus. This skeletal activity, as embryologists have shown, is preceded by reactions that occur when the buccal or peribuccal regions, and later other parts of the body, are stimulated. The motor activity of the foetus is begun by contacts or collisions between its body and the uterine wall, produced by the mother's active or passive movements and also by various parts of the foetus's body touching each other (head, trunk, limbs). The reflexes that appear and put the muscles, tendons and ligaments into action produce proprioceptive afferent impulses which combine with touch afferent impulses to form reflexes. The whole can be considered as *tactility*, and this is the origin of motor activity in the foetus.

Spontaneous and provoked motility in the newborn can largely be considered as a continuation of the foetal motility and therefore as exclusively tactile in origin. This is wholly true of the visual afferents, which do not occur reflexly in darkness. One cannot say as much of the acoustic afferents, since diverse visceral, vocal and cariac sounds arise in the maternal organism, but the newborn child's behaviour does not suggest that he has been really affected by these.

The taste afferents cannot be rejected, if the foetus is really able to swallow amniotic fluid. The ability to suck and swallow correctly from birth seems to indicate that taste afferents help to assure these functions. The reactions to salt and sugar, which can be seen from the first few hours in normal newborn infants, as well as in anencephalics, seem to demonstrate this point.

From all this one must not infer that all movements in the newborn are foetal in origin. In fact, some automatisms—for example, automatic walking—cannot possibly appear until after birth.

The foetus is too closely confined in the uterus to be able to straighten itself or walk, but it possesses the ability to do these things which can only be seen when it is in a more favourable place and position. The position which most first-born babies adopt in the last three months of gestation does not seem a likely preparation for this very specialized function. A larger space, a more convenient position, and a firmer base offer favourable conditions, to which must be added alternate movements of the lower limbs and pedalling movements. Afferent impulses transmitted by the vestibular nerves may perhaps help to prepare and then to render possible straightening reflexes.

The Moro or "Arms of the Cross" Reflex

From the moment he is born, if the newborn baby is placed on a bed, or on the receptacle waiting to receive him, and his head is not firmly supported, it will fall backwards and cause abduction and elevation of the upper limbs, with extension of all their segments (forearm, hand and fingers). This is what has been termed the Moro or "arms of the cross" reflex. Observing it under different conditions from Moro's I have not interpreted it as an emotional reaction. It is in fact a reflex produced by sudden displacement of the head and neck backwards on the body axis. It can be produced in various other ways and can be inhibited by the simultaneous activation of other reflexes (eg., the grasp). It lasts for several weeks, and

generally disappears when the head has acquired greater stability. The Moro reflex is consequently only a temparary integration, conditioned by the state of static cephalic tone, and depends on inertia or simultaneous activity of the upper limbs and on the anatomical and physiological evolution of the central nervous system.

This Moro reflex, as well as the first cry, seems to lend itself to fanciful interpretations such as alarm or fright; but in fact the physiological conditions are amply sufficient to explain it.

From the "arms of the cross" reflex the newborn baby retains for a time the attitude of abduction of the arms, which may help to make breathing easier.

There are, therefore, some temporary integrations which disappear fairly quickly, particularly at the beginning of life. Examples are automatic walking in the newborn; the straightening reflex of the foot; the incurving reflexes of the trunk on dorsolumbar stimulation; the reflex backward movement of the arm, with rotation of the head and trunk, on stimulation of the scapular region; and at various intervals others. With the passage of time, reactions appear that are comparable with those that have disappeared. In contrast to the reflexes of the first few days whose centres are below cortical level, these take more personal and more varied forms, and their origin is more cortical. Authorities who have not followed young infants through the first few weeks and months of life have sometimes been mistaken in their interpretation of these reactions.

The reflexes which develop in the foetal period and continue after birth include sucking and feeding, and yawning and sneezing. These are already complex acts, or rather successions of reflexes which bring into play several organs—e.g., lips, tongue and pharynx—and several functions—e.g., sucking and swallowing. rhythmic acts which continue for several months until weaning brings a change of diet.

Integration, then, is only a provisional process. The infant a few months old cannot be compared with one on its first day, or in its first few weeks, for evolution and the effects of multiple integrations have made him an entirely different being.

It is clear that the reflexes which persist are related to vegetative life. A fair number of infants bring their fingers to their lips from the first day of life, or soon afterwards. The phenomenon is not constant, but it is probably the continuation of a reflex gesture acquired during foetal life. In some infants finger-sucking persists, and this habit may continue beyond the first few months. This gesture is then deeply integrated but useless, thought it may sometimes persist as a need; it certainly gives the baby some satisfaction. It is tempting to deduce that integration is not always obligatory and useful, for this simple reflex bringing of the fingers to the lips, set off during foetal life, may later become a habit with no physiological basis.

Of greater interest is the life of the infant considered as a sensitive-sensory being. He is still a tactile being, but he depends on a tactility that is largely new, for the stimuli are no longer the same—they arise from new contacts with things and people. The newborn baby acquires a certain amount of freedom but loses it almost at once because the wrappings inflicted on him limit his movements. He is still most affected by visual afferent stimuli and less rapidly by acoustic ones. These sensory afferent stimuli represent new and definitive integrations which change and multiply with the baby's general development, with the new sights that he sees, and with the various new experiences registered in nerve centres. It is these which, by association, are called on in turn to create new integrations.

Light and Darkness

Before he can perceive people or things, the child must know about light—how to tell brightness from darkness. This is an

early and exciting affair, for it can be observed in the first ten days—often on the fifth or sixth day or even sooner, according to some observers.

In the first few hours of the baby's first day he begins to open and shut his eyes, separately or together. At first, if his head is turned to the right or left, his eyeballs will move in the opposite direction (doll's eyes). A little later, the angle of rotation staying the same, the eyes move so as to look ahead. This doll's eyes reaction does not last long, for it disappears in the first ten days. One can easily imagine that there is a conflict between the movement of the eyeballs determined by the movement of the head (labryinthine reflex or afferents of deep sensibility) and the retinal image.

To tell whether or not the child can see, the simplest test is to put him facing the light. The baby is held upright by an assistant and is first made to face the darker part of the room; he is then turned on his body axis so that he faces the lighter part of the room. The baby's head and eyes turn more quickly to this bright part of the room; the eye nearer the window opens wider than the other and finally the head and eyes are raised so as to point at the brightest spot—towards the sky. If the rotation of the baby is continued so that his body is turned away from the source of light, his head and eyes will not follow the rest of his body while the light is still visible. They will return to their original position only when the light gives way to complete darkness.

Undoubtedly, then, light is being perceived—the child can see. The experiment will not be entirely successful if the light is too bright, for then the baby will shut his eyes to protect his retinae.

When the baby is resting with his eyes shut, if an electric torch is turned on his eyelids, his eyes will open, and then close immediately. There are two possibilities here, depending on the intensity of the stimulus and on the reflex of attraction or the reflex of protection. In this way the reaction occurs spontaneously from the first test and therefore is not a result of education or training. At about the same stage, if one of the baby's eyes is covered with a screen placed a little distance away, his head and eyes will move towards the light. This is the oculocephalic rotatory reflex to darkening.

Sight progresses rapidly, and from the 15th to 20th day the baby's head and eyes will follow an object moved horizontally before his eyes, keeping pace with its speed and angle of movement.

Is Integration Inborn?

It is conceivable that the faculty of integration is inborn. If one studies a newborn breast-fed baby nursed by his mother, an experiment will show that he is already capable of telling the difference between his mother and another woman.

He is held in a standing position with his mother facing him. She holds her arms out to him and offers him an object to attract his attention. He of course will not hold out his arms to her, because he has not yet learnt how to use them, but his body will lean forward and bow down unless he is stood up, in which case he will move forwards towards his mother.

If she moves without the baby seeing her, and goes behind him, calling him by name, he will lean over or throw himself backwards. If the mother is behind and to one side of him, the baby will lean his body axis over laterally, turning his head and eyes to the same side at a convenient angle and following the direction of the sound, and he will smile.

If this experiment is repeated with another person it will fail. The observer is surprised to see the child responding to his mother's caressing voice and its intonation. It is a vocal and auditory caress for the child who recognises his mother, and who, in spite of his limitations, turns his head, eyes and body towards her and adds an affectionate smile. This test says a great deal for the rapidity of psycho-affective integration in the cerebral cortex, for it is difficult to assign the reaction to

any other centre.

At this age, the senses of sight and hearing begin to be closely associated. If either of these senses is stimulated the motor reaction of the body axis is correctly carried out from the first.

One should note not only the baby's ability to recognise his mother by sight and voice but also the correct motor reaction of the body axis and how the baby looks the right way. This extremely important synergism, not the result of trial and error or education, must lead us to suppose that there is an inborn mechanism. It is true that a baby aged 3-4 weeks is already accustomed to the sight of his mother and the sound of her voice, but in the conditions of this experiment the memory of her appearance and her vocal intonation is involved. Whatever its explanation, the baby's smile produced in this experiment is not usually very surprising, for 3-4 weeks is the age when babies start to smile on seeing or hearing their mother.

The smile can be seen at an earlier age if the baby is observed immediately, a few seconds, or a few minutes after a feed. Is this a true smile—an expression of blissful satisfaction—or is it only a reaction of visceral origin? There is little doubt about its nature when the smile is accompanied by a symbolic quivering, when it is close to becoming a laugh.

All these reactions of the head and neck, and then of the trunk (the body axis), represent definitive integrations, but they are changeable, particularly in relation to their origin and the baby's age.

Grasping on Seeing

Movements of the body axis in response to visual stimuli appear early. Those of the limbs come later. Movements of the lower limbs, and the synergies which control their movements, appear much sooner than those of the upper limbs. Here the lower limbs must be considered as a prolongation of the trunk and body axis, for whose support and transport they are responsible.

Grasping on seeing an object does not appear much before the fourth month—or the third month in exceptional cases—but once it has begun its progress is relatively rapid. Before this—in fact, from birth—placing an object in the baby's hand makes him close the hand. If the observer pulls the object towards him, producing a fairly marked degree of wrist extension, the object will be tightly held; this is *grasping*. If the pull is increased, the baby's upper limb will extend and his body will follow the movement and move out of the plane in which it was lying. If the child is held face downwards, by a hand under his abdomen, over a table on which there is a piece of paper or other material, the baby will take this in his hand and bring it to his mouth, if he is in the habit of sucking his thumb.

Examination of the reactions of the hand shows that a light touch on the palm just below the crease of the wrist makes the fingers open. If the stimulus is carried down towards the palm, the fingers are energetically flexed. This double reflex helps to explain how the baby takes hold of an object. Sight does not play any part in this action. Nor does it play any part in the baby's getting hold of a fold of a sheet and pulling it towards him. A similar process occurs later when the baby's hand meet the bars of his cot. This method of holding does not seem to be used by the seeing child, when he grasps an object he has seen; but it may well be used by the baby who is born blind, who must develop an exquisite sense of touch which the seeing child never acquires.

To return to the taking hold of an object seen—this appears later and is more easily obtained when the object is offered by the child's mother. Again, affectivity must play a part here.

This integration on reaching for an object seen is remarkable. At about the same time the baby develops reactions of convergence of the eyeballs according to distance; the distance of the object per-

ceived visually determines the amplitude of the movement made to take hold of the object. This is really a mathematical synergism, when one considers how perfectly the two actions must work together. The movement of the upper limb seems more complicated and more analytical if one considers the grasping of the hand and the segmental movements of the arm. At the beginning, some infants show a certain amount of hovering over an object before picking it up. Sometimes one hand is more hesitant or slower than the other —for example, the left hand in a markedly right-handed child. Prehension is quickly associated with digital manipulation, then with actions that are somewhat more clearly intellectual, such as the choice of an object, colour preference, form, volume, and two-handed combinations, and later the motives behind prehension. In these ways the child learns dexterity, speed and precision. Sight does not always come into the picture until education is more advanced. When the baby has correctly grasped an object with one hand, if the back of the other hand is touched lightly it will at once be turned over to grasp the examiner's finger. A long period of learning is not necessary for progress, which is undoubtedly conditioned.

While the hand is gathering information about the outside world, it also acquires, or rather confirms, the baby's information about himself and the two sides of his body. Integration of this function improves indefinitely. Its beginning marks an important stage in the child's knowledge of himself and the outside world.

After an infinite number of experiments with manual activities controlled by sight, the child succeeds in controlling them without sight. Sight must originally have played an important part in the acquisition and execution of an action which now seems to be done without visual help.

Using the Limbs

Once the sitting posture has been acquired and can be maintained, the field of prehension enlarges. When the limbs and trunk co-ordinate their actions in grasping an object, they help each other to establish or re-establish balance, the upper limbs being used not only for reaching and grasping but also for support and balance.

At this period of life the infant shows remarkable ingenuity and a surprising measure of discernment. If the right arm is paralysed whether by pre-natal compression or by traction on the cervical roots—and the paralysis progressively improves, the restoration is sufficient for the right side to get back its powers if the child is right-handed. He now knows what he can or cannot do. For example, he knows how high he can raise his right arm, and how far it is inferior to the left arm, and this with striking rapidity considering that the child is only a few months old.

The test of placing a handkerchief on the child's face is no less interesting if the child is closely watched. The very young child tries to get rid of it by movements of his head and neck, and later by thrashing (windmill) movements of his arms. Later still the hands come together in pronation, they then go into supination to grasp, and they return to pronation removing the handkerchief. Some babies remove the handkerchief more quickly with their right hand. All this is done and co-ordinated with a perfection that results from cortical elaboration.

The activities of the upper limbs are not confined to this kind of exercise; the arms play an important part in learning to walk upright. This can be seen by walking babies alone in a play-pen and seeing how they learn to straighten themselves, pull themselves up, and walk, using their arms as balance poles to maintain their equilibrium. Later the arms will play a part in walking, putting the trunk into the most favourable position

for progression. To a certain extent the human child behaves like a quadruped.

Right-handedness

The predominance of the right hand does not attract the same amount of attention in all mothers. It is, however, an important phenomenon, for it marks a decisive stage in the physiogical and psychological development of the brain: this is the first sign of the dominance of the left hemisphere.

Right-handedness is certainly an early sign of this dominance, but through the multiplicity of actions and the numerous integrations which operate in the following weeks, months and years its dominance is reinforced. Function does not make the organ, but it plays a large part in establishing its supremacy.

Conversing

At the very beginning of life, before the baby can talk and even before he begins to listen to his mother's words, they understand each other and can converse by gestures. To these signs the mother adds her facial expression and the muscular actions that produce words.

Even the shortest affective or emotional interjections are easily grasped by the baby.

Words of ordinary conversation leave more than auditory impressions, particularly when they are polysyllabic. Watching his mother's gestures and imitating them contributes a great deal to the baby's comprehension. It is thus mainly auditory-motor impressions that are registered in the child's nerve centres. The manual gesture, or the action executed by the child at his mother's request, originates in his left hemisphere, and the registration of his mother's activity is mostly thought to occur in the same hemisphere. The simultaneous or regular succession of impressions coming from the mother and her baby play a large part in awakening consciousness.

It should also be noted that the first words utilise the play of the lips in pronouncing consonants, and that the lip movements reproduce an act that is frequently performed from the first few days of life.

The Right Hand of Love

The right hand is also responsible for manifestations of affection. It is the hand that caresses, as much in the mother as in the child, and affection is of great importance in the baby's intellectual development and behaviour. The right hand may also become, in certain circumstances, the opposing hand. The right hand leaves a certain amount of motor activity to the left hand, but only conditional and to some extent subordinate activity.

Even before manual activity can show itself in meaningful actions—from the third and fourth week—the infant can distinguish his mother from other women, recognise the intonation of her voice, and show his satisfaction by turning towards her bringing his body axis into play in this way by turning in the direction from which he hears her voice. The axial reactions precede manual reactions, and are performed equally on the right and left sides. It is only later, when the right hand can perform gestures, that the right side of the body is more often brought into play by the limb attached to it.

It is really when prehension begins that right- or left-handedness first manifests itself, and particularly when the child can sit up by himself. But there is a wide individual variation in whether right predominance appears early or later. The use made of the left hand, and the extent to which it falls behind the right in performance, is also variable.

With education, the predominance of the right hand becomes much more evident because of reading and writing, but the progress of this hand becomes more and more exclusive. Spontaneous language appears long before education

starts, and, as has already been mentioned, it is preceded by a long period of mutual comprehension of gesture, facial movements and mimicry. Progress is slow, and the first words often come as a surprise.

The Left Hemisphere

Localisation of language in the left hemisphere occurs early, and any lesion which affects this zone has unfortunate repercussions on language function, causing aphasia in a child who can already speak and delaying speech in a child who is still in the preparatory stage. Nevertheless, aphasia in children is less lasting and severe, and substitutions are more easily made, than in a brain whose left hemisphere has played a dominant role for a long time. In a right-handed adult aphasia is less easily cured than is the concomitant hemiplegia by the substitution of the left hand for writing. All the same, the aphasic who has lost the use of language for several months still possesses a certain amount of mental activity which allows him to think, judge and discern. He is like a child who has not yet learnt to express himself verbally and yet behaves in an intelligent fashion, which shows that he pays attention and remembers various events, and particularly those in the realm of affectivity (desire, fear, joy, etc.). He has lost little, it is true, compared with the older patient with a right hemiplegia and aphasia; every day knowledge is silently acquired. It is thus that, in everything that concerns language and psychomotor activity, the ego becomes more and more attached to the left hemisphere with a real predilection. The ego is more affected by damage to the left than to the right hemisphere. Language does not monopolize all thought, but thinking activity is singularly reinforced by all the advantages of speech. Although the right and left hands do not have equal abilities, and the right hand always takes precedence over the left, each hand takes into account its need of the other—as much in defence as in attack. We must again underline the role of affectivity and how promptly it acts; its promptitude is particularly striking when one considers the perfect synergism brought into play in time and space: the reaction is as quick as a reflex, though it originates in the cerebral cortex.

The Contributions to Progress

One may deduce from this brief survey that from the earliest days intelligence, and consequently the brain, sets to work to take conditioning in all its forms into account. The five-day-old baby whose feeding is interrupted, and whose position is then changed, will, as soon as he is put back in the previous feeding position, go on making sucking movements in space without being fed and without seeing the breast or the bottle.

The baby's spontaneous behaviour, and the reactions brought about in the earliest stages, show the importance of the part played by affect — that is to say the property of the organism to react in the sense of attraction or repulsion—according to whether the stimulus used is useful and agreeable, or useless, disagreeable and nociceptive. A little later, near the end of the first month, the influence of affectivity intimately linked with acquired knowledge manifests itself. Psychomotility and psycho-affectivity then assert themselves and interact and develop reciprocally.

In place of the afferent impulses of the primary reflex activity, sensations and then feelings begin to act as stimuli. Subcortical predominance is succeeded by cortical predominance, which is better adapted for analysis, differentiation and discernment.

The integrations of the earliest days mostly disappear—e.g., the automatic walking of the newborn. It is not until several months later that free, definitive walking begins. This is not a reappearance of primary walking, though certainly segments of the subcortical neuraxis are

not excluded, but they are now controlled, and reactions are present which did not exist at the time of the first walking movements.

Reflex automatisms, which account for the motility of the newborn baby, give way to cortical automatisms, which establish themselves with extraordinary rapidity. Multiple and successive integrations maintain a facility that is very close to primary reflexivity, if not equal to it, and this is so as much in the realm of motility as in psychomotility and affectivity. At this period wide individual variations appear, taking into consideration the baby's heredity and constitution, and the environment in which he is being brought up. Furthermore, after the first months, or the first year, great changes take place because of the development and growth of certain organs such as the endocrine glands. The progress likely to be made by the mature being is not so easy to foresee, and our prognosis must allow for favourable or unfavourable surprises. If illness interferes, the child's age at the time, and the nature and duration of the disease can greatly influence the effect of the illness on his development.

Functional integrations appear in a fairly constant sequence; consequently the effects of cerebral disease vary according to the stage of development which the child has reached when disease occurs. If it is severe, early, and destructive, motility and psychomotility may be seriously affected. If the illness attacks the child after he has learnt to walk, walking may continue, even though the child remains incapable of all new adaptive activity, all affectivity, and all educability. If the illness occurs just after prehension has been acquired, the child will remain incapable of sitting, standing and walking, although manual activity is retained and continues to develop. The ultimate effects of the illness in the individual case depend on the site and severity of the attack, and on the diverse changes left in the wake of the morbid process.

Observers are usually surprised by the behaviour of patients whose intelligence and affectivity have been spared and who make the best of their remaining motor ability, making up for their lack of synergic neuromuscular combinations by making use of gravity and synergisms that they create personally. These patients in a sense, invent automatisms to suit their own particular conditions.

These few remarks may reveal something of the complexity of functional integrations, of their appearance, and of their transformation at each stage of development. The rapidity and the adaptation of movement are subordinate to the correct association of dynamism and regulation. This adaptation is more striking in all that concerns automatic walking, climbing, feeding, and the first attractions and repulsions.

The Cerebellum's Role

The role of the cerebellum in motility in the adult is well-known under the name of regulation. It makes itself felt from the first actions—for example, the regularity of automatic walking in the newborn which can sometimes be observed a few minutes after birth. The infant who brings his fingers to his mouth makes no mistake—his fingers do not go to any other part of his face. If his hand grasps a cloth and takes it to his mouth the movement is a correct one, whether done slowly or quickly. Nevertheless, the development of the cerebellum is not complete, for in examining sections of the neuraxis of the foetus one can see that only certain systems, such as that of the inferior cerebellar peduncle, are already developed and myelinated. Withdrawal of the lower limb produced by plantar excitation is none the less well co-ordinated and regular; the same is true of the crossed extension and adduction reflex produced by the same stimulus. In the child and the normal adult, are not the osteo-tendon reflexes and cutaneous

reflexes correctly executed?

The regulatory action of the cerebellum is complex, and, thanks to the special action of this organ on muscle tone, it makes itself felt as much in reflex activity as in spontaneous activity. It is possible, however, that at first certain reflexes are not obtained in cases of cerebellar deficiency, in the infant as in older patients, because in them tone at rest is not anatomically or physiologically comparable, by reason of the incomplete development of the neuraxis.

Permanent muscle tone is not the same in an anencephalic as in a normal newborn baby, but this does not prevent certain reflexes existing in both of them. This is true of the reflexes which bring segments of the neuraxis into play. Sometimes, these reflexes are accomplished by anencephalics with marked brusqueness, as if they had not been modified by the moderating waves coming from higher centres, as they normally are.

Conclusion

These notes do not pretend to cover all aspects of the vast subject of functional integrations. But, just as reflex activity in the infant occurs at the slightest provocation, so we hope the readers mind will be stimulated to act as quickly. The result may be to facilitate discussion and bring forth a richer and more instructive documentation.

LITTLE MILESTONE

With this issue the "Bulletin" reaches the end of its second year and the end of Volume I. From No. 9 onwards the pages will be numbered consecutively throughout the eight issues of Volume II. Anyone who cares to send the Editor the first eight numbers can have them bound free of charge. Missing back numbers are obtainable for 5s. each; and a few copies of Volume I will shortly be available ready bound for 45s. An Index of Volume I is in preparation. It will be sent to all subscribers when ready, and to others on application to the Editor.

THE NEUROPATHOLOGY OF CEREBRAL PALSY AND ITS IMPORTANCE IN TREATMENT AND DIAGNOSIS

A. THE CEREBRAL PALSY PROBLEM. B. NORMAL DEVELOPMENT OF MOTOR ABILITIES. C. CAUSES OF MOTOR HANDICAP IN CEREBRAL PALSY. D. EARLY DIAGNOSIS.

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In the cerebral palsied child early treatment seems desirable but impossible for lack of active cooperation by the patient. Dr. and Mrs. Bobath have used inherent motor reactions to promote good movement patterns even in infancy. This "meaty" article gives a postgraduate course on the postural reflexes underlying our equilibrium, their emergence and later integration and inhibition in the normal infant's early years.

A knowledge of these reactions and of the abnormal reflexes of the cerebral palsied child will help us to recognise the postures displayed and to understand the ideas underlying the Bobaths' methods of treatment.

"A"
THE CEREBRAL PALSY PROBLEM

Cerebral palsy is not a single disease but a group of conditions, resulting from brain damage through factors operating in utero or in the paranatal period. The lesion is persistent and non-progressive, and leads to a motor dysfunction, an impairment of the co-ordination of muscle action, frequently associated with various sensory disturbances.

Incidence

On the basis of an extensive statistical survey, Phelps (1948) estimated that 7 infants born each year in every 100,000 of the population were likely to suffer from this condition. More recent studies have shown that this estimate is probably too low. Asher and Schonell (1950) found the incidence to be about 1.7 per thousand births, and Woods (1957) thinks that about 1.9 per thousand infants who reach the age of five years suffer from cerebral palsy. From these and other surveys, it appears that the incidence of this condition is 1 to 2 per thousand children between the ages of 5 and 15+.

Classification

The classification of cases has proved very difficult, and so far no satisfactory and generally acceptable scheme has been devised. The reasons for this are as follows. First, there is still a lack of correlation of clinical and laboratory data

with autopsy and anamnestic findings. Secondly, cerebral palsy has many causes, and too little is known about the aetiological factors responsible for a certain type of motor dysfunction to make aetiology a useful factor for classification. Moreover, many cases of cerebral palsy are of a mixed type and do not fit readily into any clear-cut scheme. The difficulty is increased by the fact that modern neurophysiology has thrown doubts on the existence of the pyramidal tract as a functional unit and has questioned the wisdom of separating cases with pyramidal from those with extrapyramidal symptoms.

It seems best, therefore, at this stage of our knowledge, to use a simple and purely descriptive classification. The proposed scheme combines the distribution of the handicap with the type of abnormal muscle tone, the factor common to all cases of cerebral palsy, as follows.

1. *Diplegia*

The whole body is affected, the legs more than the arms. The distribution is more or less symmetrical. Most spastic children belong to this group, although some of them may also show slight athetoid movements of the distal parts of the limbs.

2. *Quadruplegia*

The whole body is affected, but the arms more so than the legs, or arms and legs are equally affected. The more severe involvement of the arms, and of the upper parts generally, results in poor head control and often in defective speech. The distribution is usually very asymmetrical, owing to strong asymmetrical tonic neck reflex activity being more pronounced on one side than the other.

To this group belong a large number of cases of spasticity, with or without athetosis, of athetosis or choreo-athetosis, rigidity, ataxia and flaccidity. Many cases in this group are of a mixed character. Some of the athetoid children in this group show a muscle tone which fluctuates between hypo- and hyper-tonia —that is to say, they show intermittent spasms due to tonic reflex activity against the background of a low muscle tone. This group may be classified separately as "dystonic". Their involuntary movements are at least partly due to their unsteady muscle tone and to intermittent spasms interfering with voluntary movements. They involve the more proximal parts — head, trunk and shoulders — whereas hands and fingers may show a fairly normal co-ordination.

A small group of athetoid and choreo-athetoid children show a muscle tone which fluctuates between hypotonia and normal, though it is generally rather low, with weak or absent tonic reflexes. In slight cases involuntary movements may just be twiches or sudden jerks, involving especially the trunk, neck and shoulders. In more severe cases the involuntary movements are slow and writhing, and mainly affect the limbs.

In the choreo-athetoid child, involuntary movements are large and abrupt, and they involve the proximal joints more than the distal ones.

Some spastic children may show minor degrees of athetosis affecting the hands, fingers and feet.

Some children of this group, but also some diplegics, show "rigidity"—that is, a plastic type of hypertonus.. This is characterised by absence of the clasp-knife phenomenon typical of spastic muscle, and by an unchanging resistance of a muscle group to passive movement in either direction, of flexion or extension. It is very difficult to differentiate between this type of case and the spastic child. Both types of hypertonus, spastic and plastic, may be seen in the same child at the same time, in different muscle groups; or a rigid young child with a plastic hypertonus may in time develop a fluctuating muscle tone in the same muscle groups. He gets more mobile, develops intermittent spasms and becomes "dystonic".

Pure ataxia in cerebral palsy is rare. It is usually associated with spasticity, athetosis or both. The ataxia may be of the motor type, resulting from damage to the cerebellum or cerebellar connections, or of the sensory type, caused by damage to cortical or subcortical sensory structures of the brain. Spasticity is usually mild in these cases and affects predominantly the flexor groups of muscles.

In very young children a state of cerebral flaccidity is not uncommon. These children may in time develop spasticity or rigidity. They may also become athetoid or dystonic later on, when trying to move voluntarily, or to speak. The whole body may then stiffen in a sudden extension and tonic reflexes can be seen. These intermittent spasms have been observed by Ingram (1955) and called "dystonic attacks". The early state of flaccidity may, however, persist throughout life. This is especially so in children with considerable intellectual impairment.

3. *Hemiplegia*

One side of the body is affected. Muscle tone is usually of the spastic type. Some children may develop athetosis of the distal parts later in life.

4 & 5. *Cerebral Paraplegia and Monoplegia*

These are very rare in cerebral palsy. Most of the paraplegias are really diplegias and most of the monoplegias are in fact hemiplegias, in which the arms or arm are so mildly affected that this may be overlooked.

Aetiology

It is generally accepted that, out of every 100 cases of cerebral palsy, 60 are of paranatal origin, while 30 are caused by prenatal and 10 by postnatal factors. This is confirmed by a recent important study of aetiological factors undertaken in Denmark by Brandt and Westergaard-Nielsen (1958). In analysing 628 cases of cerebral palsy, the authors found that prenatal and paranatal factors were responsible for 87%, whereas postnatal factors accounted for only the remaining 13%. Prenatal factors, including prematurity which alone caused 36% of the total, accounted for 54% of all cases of symmetrical diplegia and 41% of the asymmetrical diplegias (these might be the quadruplegias of the above classification). Paranatal factors accounted for most cases of athetosis.

Prematurity (27%) and neonatal asphyxia (23%) were found to be the most frequent single causes of cerebral palsy. Comparative figures for prematurity as a cause are 24% (Bobath and Bobath 1956) and for neonatal asphyxia 38% (Ascher and Schonell 1950) and 40% (Bobath and Bobath 1956). Prematurity seemed to be 3-4 times more often the cause of spastic diplegia and paraplegia than of extrapyramidal hyperkinesia. Neonatal asphyxia, on the other hand, was 3½ times more often the cause of extrapyramidal hyperkinesia. Moreover, the latter carried a higher risk of an associated mental defect with motor dysfunction, than prematurity alone.

Associated Defects

Associated handicaps are those affecting vision, hearing and speech. Various sensory disturbances, intellectual impairment and epilepsy can also be seen. It is beyond the scope of this article to give more than a brief description of these defects.

Disturbances in the co-ordination of the eyes are frequently met with, especially among the quadruplegics. Guibor (1958) has estimated that 50% of all cases of cerebral palsy have some motor defect of the eyes. This shows itself mainly in an inability to focus properly. Internal and external squint, either fixed or alternating, and lack of accommodation are common. Many children are unable to move the eyes independently from the head. Some athetoids with strong neck retraction find it difficult to look down.

A strong asymmetrical tonic neck reflex in a spastic or dystonic child may fix the eyes laterally towards one side, and prevent the child from moving the eyes across the midline to the other side. Some ataxic children and athetoids with poor head control and nystagmus cannot fix an object or follow a printed line.

Total blindness is rare in cerebral palsy. An impairment of vision resulting from cortical damage—a partial visual agnosia—is more common. Impaired vision may also be caused by retrolental fibroplasia and by optic atrophy. Defects of the visual fields are not uncommon, especially in hemiplegic children (Tizard 1953). These are caused by damage to the optic radiation.

The commonest disturbances of hearing are high-frequency deafness and auditory agnosia or imperception. High-frequency deafness is often seen in certain types of athetosis due to neonatal jaundice. In a recent otological and audiological evaluation of the hearing mechanism of normal and premature children at the age of 6-7 years. Campanelli and his co-workers (1958) found that in a group of 44 premature children 7 had some hearing loss, whereas none of the 44 children in a control group of normal children were affected. The loss was uniformly bilateral, of the high-frequency type, with an accompanying loss of bone-conduction. These authors suggest that all premature children should be suspected of some impairment of hearing until examination has excluded this possibility. Fisch (1953) has estimated that about 20% of all children with cerebral palsy have some hearing defect.

Hearing defects are often responsible for delay in the development of normal speech. Many children have a dysarthia—a pseudobulbar palsy of a spastic, athetoid, ataxic or mixed type.

Pure motor or sensory aphasia is rare in cerebral palsy. Other associated sensory disturbances are either a corporeal or spatial agnosia. The corporeal agnosias may involve parts or the whole of the body. Hand- or finger-agnosia is not uncommon and has been studied especially in hemiplegic children. The involvement of the whole body may lead to a more or less severe impairment of the child's concept of his own body, the "body-image". The corporeal and spatial agnosias may not be wholly due to cortical damage but may be partly the result of the child's inability to use his hands to reach out, to grasp and manipulate objects, and to explore his own body and space. He often cannot develop proper eye-hand co-ordination and therefore does not gain sensory experience.

Mental retardation or defect is often very difficult to assess in children with cerebral palsy, especially if they are severely affected and cannot communicate or manipulate objects. In all cases suspected of mental defect, care must be taken to exclude the associated handicaps mentioned above before making a decision. These handicaps may make it difficult to assess intelligence accurately even in the mildly handicapped child.

It is generally agreed that of 100 children with cerebral palsy:—

50 are of superior or normal intelligence;
25 are of subnormal intelligence but are likely to profit from education in special schools; and
25 are mentally defective to varying degrees and unlikely to profit from any kind of education.

Epilepsy is common in cerebral palsy and may be of any type—grand mal, petit mal and Jacksonian. Estimates of the incidence of epilepsy in cerebral palsy range from 68% (Yannet 1944) to 14% (Dunsdon 1951). If these fits are well controlled by drugs they are not a contra-indication to treatment.

Nature of the Motor Handicap

In spite of the wide variety of the clinical picture, all cases of cerebral palsy have an abnormal muscle tone and impaired co-ordination of muscle action, resulting in inability to maintain normal

balance and to perform normal purposeful movements and acquire normal skills.

Normal muscle tone is necessary for the performance of normal movements. Muscle tone should be steady and of moderate intensity if performance it to be smooth and precise. It must allow for the movement and for the necessary postural adjustment of the whole body in support of the movement. Every one of our many activities—sitting, standing, walking and running—causes a constant change in the relationship of the body to the supporting surface. This involves changes of tone throughout the whole body musculature. These changes take place automatically and without our conscious participation. They maintain our posture and equilibrium during all our activities.

A group of automatic reactions perform this function, and they have therefore been called "postural reactions". Most of them are subcortically integrated at various levels of the neuraxis. These postural reactions form the background for all normal movements and skilled activities. Unless they are fully developed, and their integrated action is established, these normal acts are impossible. For instance, we cannot use our hands freely for manipulative activities unless we can keep our balance without using them for support.

Muscle tone and its regulation for moving and maintaining balance is centrally co-ordinated in definite patterns. The motor handicap of children with cerebral palsy arises from interference with the postural reflex mechanism by the lesion. The result is a release of abnormal postural reflexes, the tonic reflexes of Magnus (1926), from higher central control. The released tonic reflexes are closely associated with spasticity—the decerebrate rigidity of Sherrington (1947) —or with the intermittent spasms, called tonic spasms by Kinnier Wilson (1925), which we see in athetoid children. These reflexes interfere with the development of higher integrated normal postural reactions, like the righting reactions of Magnus (1924) and the equilibrium reactions of Weisz (1938), Rademaker (1935) and Zador (1938). The righting and equilibrium reactions are the prerequisite for purposeful movements and skills. Spasticity is not confined to single muscles or muscle groups but involves all the muscles of the affected parts or even the whole body in a few typical abnormal patterns of lower reflex activity.

"B"

NORMAL DEVELOPMENT OF MOTOR ABILITIES

Before discussing the reflex abnormalities which account for the postural behaviour of children with cerebral palsy, it may be useful to study the development of the motor abilities of normal children, and to interpret this in terms of the gradual appearance of normal postural reactions. This may help to a better understanding of the motor handicap of children with cerebral palsy and will give a logical approach to the treatment, assessment and diagnosis of this condition.

From birth onwards the baby develops his motor abilities in a definite sequence (Gesell and Amatruda 1949, McGraw 1943, Griffith 1954). The gradual development of the postural reactions gives the baby proper head control and assures a normal position of the head in space and in relation to the trunk. With the help of these reactions he also acquires the normal alignment of head, neck, trunk and limbs, and learns to maintain his equilibrium during his activities.

I. The Righting Reactions

The first reactions to come into play are the righting reactions. These develop from birth onwards, reach their maximal concerted effect around the age of 10-12 months, and are then gradually modified and inhibited, to disappear towards the end of the 5th year. They safeguard the normal position of the head in space (face vertical, mouth horizontal) and secure the normal alignment of head, trunk and

limbs. They guide the baby's behaviour throughout the quadruped stage, and are gradually integrated into the baby's volitional behaviour. To them belong:—

(1) *The neck-righting reaction.*—This is present at birth. Turning the head to one side, either actively or passively, is followed by rotation of the body as a whole towards the side to which the head is turned. From lying supine, the baby turns on his side.

(2) *The labyrinthine righting reaction acting on the head.*—This comes gradually into play from the 4th to 6th week onwards. At first the reaction is weak and the baby raises his head in the prone position. Later, as it gains strength, the baby begins to raise his head, from the 6th month onwards, in the supine position.

(3) *The body-righting reaction acting on the head.*—This reaction serves to right the head in response to some part of the body touching the supporting surface. For instance, righting the head will follow when the baby's feet touch the ground. This reaction interacts closely with the labyrinthine righting reaction on the head to secure and doubly-secure the normal position of the head in space.

(4) *The body-righting reaction acting on the body.*—This reaction appears around the 6th to 8th month of the baby's life, and modifies the primitive neck-righting reaction by introducing a rotation of the trunk between the shoulders and pelvis. By turning the head to one side the child will now be able to start the movement of the trunk with the shoulder, while the pelvis will follow, or vice versa. It is this rotation within the body axis which gives the baby his first chance to turn over to the prone position when he is about 8 months old. Turning over from supine to prone is aided by the child's ability to raise the head when lying prone and to extend his spine and hips.

(5) *The optical righting reactions.*—These are of secondary importance at first but gain quickly in influence as the child grows. In the adult, vision has become the main factor in maintaining the normal position of the head and body, while the other righting reactions have fulfilled their function and have become inhibited.

All the righting reactions interact closely and secure and doubly-secure the normal position of the head in space and the normal alignment of the body and its parts. A simple means of showing their activity in the growing child is to observe how he sits and stands up from the supine position (Schaltenbrand 1923). As long as the righting reactions are active, the child will do this by first turning over to the prone position, getting up on his hands and knees, and then sitting or standing up. As the righting reactions are gradually inhibited and disappear, the rotation of the body will become less and less pronounced, and by the fifth year the child will get up in the adult symmetrical manner. He will sit up straight from lying supine and then stand up.

II. The Equilibrium Reactions

Like the righting reactions, the equilibrium reactions appear in a definite sequence. The first equilibrium reactions can be seen around the 6th month, when the righting reactions are already almost fully established. From then on they gradually modify and inhibit the righting reactions. The equilibrium reactions have complex and varied motor patterns, and require for their proper function the full interplay of the basal ganglia, subthalamic nuclei, the cerebellum, and probably the cerebral cortex. They remain with us throughout life, and serve to adjust posture and maintain equilibrium. They are essentially compensatory movements, making the maintenance of equilibrium possible, and are activated by changes of the position of the body in space or by a change of the relationship of body and supporting ground, as for instance, when standing on a moving platform. They can therefore be demonstrated in two ways—either by putting a child on a moving platform, like the "Rademaker table"; or by pushing the child gently from side to side, or forwards and back-

wards when sitting, kneeling or standing on the ground.

The first reactions to tipping on a moveable table appear in the prone position around the 6th month and in the supine position shortly afterwards. Before that time the baby just rolls off the table when it is tipped without any adaptive and protective reaction. From the 6th month onwards the baby lying prone bends the head and arches the body towards the raised side of the table as a result of a compensatory increase of tone in the muscles of the raised side. The arm and leg of that side are abducted and the hips often rotate towards the lower side of the table. The reaction to tipping when lying supine is identical.

The perfecting of all equilibrium reactions lags somewhat behind the child's attempts at more difficult activities. For instance, the equilibrium reactions in the prone and supine positions appear, and are perfected, at a time when the child can already sit, though he cannot yet sit up by himself. The necessary equilibrium reactions, which enable him to sit up and keep his balance in sitting, appear only when the child tries to stand up.

The equilibrium reactions in sitting can be tested by moving the child at varying speeds from side to side, or backwards and forwards. If the child is gently pushed to one side—for instance the left—the head moves towards the right; it angulates with the body and tends to maintain as far as possible the normal position in space. The right arm and leg abduct and extend, and the right hip moves forward while the left arm and hand extend, ready to support the body weight if the reaction fails (fig. 1). When the child's centre of gravity is disturbed by pushing him backwards, his head, shoulders and arms move forwards and his legs extend. Pushing the sitting child forwards makes his legs flex, his spine and neck extend, and his arms move backwards.

The equilibrium reactions to moving the child in the kneel-standing and standing positions are very similar to those in sitting (fig. 2 and 3). However, in standing other reactions can be observed as

Figs. 1, 2, 3, and 4—Equilibrium reactions on sitting, kneeling and standing.

well. The child may keep his balance by making a few sideways steps in the direction of the weight transfer. If the child is moved backwards he will either step backwards or will move his head, trunk and arms forwards and dorsiflex his ankles and toes to counteract the transfer of his body weight (fig. 4).

These are only a few examples of the many typical reactions which can be observed. The variations of the reactions depend on the range and speed of the movement which disturbs the child's equilibrium. They have been studied in great detail by Zador (1938).

Modification of the Baby's Motor Patterns by Inhibition

As the child passes from a stage of primitive reflex activity and learns to right himself and get his balance, he gradually begins to use the automatic patterns for voluntary activity. By integrating visual, auditory, proprioceptive and tactile sensations, he learns to change and adapt the existing patterns of movement to locomotion and manual activities. To do this, he has to learn to combine the motor patterns he knows in various ways, and must be able to time and direct his movements. The original total patterns are inadaquate for the various activities of the growing child, and have therefore to be modified and partly inhibited. The child has to learn to use only parts of the total patterns and to combine them in various ways in order to cope with everyday tasks.

For instance, having at first learnt to grasp an object and hold it close to his body, he will have to learn to grasp and hold it while reaching out. He must not open his hand and let it drop, whether his arm is above his head, hanging by his side, or in any other position. He will at first grasp the object with his whole hand and all his fingers, but later, when he wants to pick up crumbs or hold a small object he will have to restrict the grasp to thumb and forefinger only, while moving the other fingers out of the way. He will at first bend his legs at all joints when kicking and will have to change this total pattern to flex his hips with extended knees when lying on his back to play with his toes. This will prepare him to get on his feet from kneeling, when he first stands up to walk on his hands and feet, shortly before taking up the upright posture.

These few examples show how the child gradually gets control over his original primitive and total motor patterns, and how he modifies and changes them so that he can learn to use them in more selective and varied ways for purposive activity. This process of modification is achieved by the gradual inhibition of those parts of a movement which are unnecessary and disturbing to the performance of a special task. It shows that inhibition is an important factor in the co-ordination of movement and posture and especially so in the co-ordination of the finest and most selective movements.

"C"
CAUSE OF THE MOTOR HANDICAP IN CEREBRAL PALSY

In the child with cerebral palsy the lesion interferes with the orderly developmental process. There is a lack of sufficient inhibitory control and a release of a lower postural reflex mechanism, of the tonic reflexes of Magnus and De Klejn (1924, 1926). All children with cerebral palsy show a retention of the primitive reflex character of posture and movement, with abnormal tonic reflex activity. Spasticity or intermittent spasms seem to be the direct result of the release of the tonic reflex activity of the brainstem, as studied in decerebrate animals, but it is perhaps wiser to say that tonic reflexes and spasticity or intermittent spasms seem to be coexistent. The degree of spasticity seems to be directly related to the strength and immediacy of the tonic reflexes.

The Relevant Abnormal Reflexes

The following description of some spinal and tonic reflexes and their effect

on the child's motor behaviour may help to a better understanding of the nature of the handicap.

1. *The Spinal Reflexes*

(*a*) *The Flexor Withdrawal Reflex.*—This involves the whole lower limb in a movement of flexion, usually with outward rotation and abduction. Thus the child is unable to flex a limb selectively in any one joint. For instance, if the child is lying prone and tries to bend his knee, he can do so only by simultaneously raising his hip in flexion. When lying supine he can dorsiflex his ankle when flexing the limb at the hip and knee, but he will not be able to dorsiflex his ankle with an extended lower limb.

(*b*) *The Extensor Thrust.*—The total synergy of this reflex consists of extension of the lower limb in all joints with plantar flexion of the ankle, and inward rotation and adduction of the leg. This pattern can be seen in many spastic children when they lie on their backs.

(*c*) *The Crossed Extension Reflex.*—This is a combination of the pattern of the flexor withdrawal reflex with that of the extensor thrust. While one leg flexes in a total flexion-abduction pattern, the contralateral leg extends, adducts, and turns inwards. This pattern can often be seen in athetoid and dystonic children, while in the spastic child it is usually inhibited by extensor spasticity of both legs, which prevents alternating kicking. However, it can be seen in the spastic child when walking, in an increase of extensor spasticity in the standing leg when the other leg is raised and flexed to make a step.

II. The Tonic Reflexes

To these belong the tonic labyrinthine reflex, the asymmetrical and symmetrical tonic neck reflexes, the associated reactions and the positive supporting reaction.

(*a*) *The Tonic Labyrinthine Reflex.*—This reflex is evoked by changes in the position of the head in space, probably by stimulation of the otolith organs of the labyrinths. In the child with cerebral palsy it causes maximal extensor spasticity in the supine position, and minimal extensor spasticity with a relative increase of flexor tone in lying prone. Intermediate degrees of extensor spasticity are produced by positions of the head between these two extremes—for instance, in sitting.

In the severely spastic child, extensor spasticity in the supine position may be very strong. The head, neck and spine are retracted, the shoulders pulled back, the arms abducted and flexed at the elbows, and the lower limbs extended, inwardly rotatel and adducted (fig. 5 a and b).

Fig. 5a.—The tonic labyrinthine reflex and its influence on the young child.

Fig. 5b.—Effect of the asymmetrical tonic neck reflex.

This extensor spasticity in the supine position prevents the child from raising his head and sitting up. Furthermore, the child cannot move his arms forwards to grasp a support and pull himself up to a sitting position. He cannot bring his arms forwards and together in the midline, and he cannot touch his body or bring his hands up to his mouth. If he turns his head to one side and tries to turn to this side, the retraction of his shoulders will prevent this.

Fig. 6.—The tonic labyrinthine reflex and its influence on the child.

When lying prone the child usually shows flexor spasticity; his head and spine are flexed, his shoulders are pulled forwards and down, and his arms are caught under the body in flexion, with his hands fisted. The hips and knees are often flexed, but if the hips are extended, the knees are usually extended as well (fig. 6). The child cannot raise his head and often cannot even turn it to one side. He cannot extend his arms, and he cannot extend his spine sufficiently to free his arm from under the body for support. Therefore, he cannot get himself up to the kneeling position.

Though extensor spasticity is always strongest in the supine position and flexor spasticity is most pronounced in the prone position, the effect of the tonic labyrinthine reflex depends on the child's initial type of spasticity. In some children extensor spasticity is so strong that it might be present still, though to a greatly lessened degree, even when lying prone. Other children may show strong initial flexor spasticity. They will show some degree of flexor spasticity even when lying supine.

If the spastic child tries to sit up, he may succeed by compromising between extensor and flexor spasticity. Since he cannot flex his hips sufficiently, he will sit with semiextended hips and bring his trunk forwards by a compensatory kyphosis. If he has sufficient head control, his head may be held in the normal position with the chin jutting out (fig. 7).

If the arms are not badly affected, the child will rely on them for support and will dislike taking both hands away from the support. He therefore uses only one hand unless he is well supported. If both arms are badly affected, they are drawn up in flexion. Raising the head and lifting the arms forwards and upwards will increase extensor spasticity generally, and the child will fall backwards (fig. 8); lowering the head will

Fig. 7.

Fig. 8

Fig. 9

ig. 7 — Asymmetrical ic neck reflex.

ig. 8—The child falls kwards through increased ensor spasticity when the d and arms are raised.

ig. 9—As Figure 8 but king down.

increase flexor spasticity and the child will slump forwards (fig. 9). Maintenance of the sitting posture is made still more difficult by the narrow sitting base produced by the adductor spasticity of the legs and the lack of balance. In time the child may develop flexor contractures of his hips and knees and a permanent kyphosis.

Fig. 10.—Early modified standing posture.

Fig. 11.—Modification of standing. Development of scissors gait.

Once the child has achieved the sitting posture in spite of the opposing forces of flexion and extensor spasticity, the picture becomes one of a combination of both, and the total pattern of either flexion or extension cannot be seen. In the same way the original picture of extensor spasticity of the legs is changed in standing and walking to that of the well-known scissors posture (fig. 10 and 11). To avoid falling backwards the child will flex his head and trunk forwards, thus introducing an element of flexion throughout the body, which affects the hips and knees to a greater or lesser extent.

(*b*) *The Asymmetrical Tonic Neck Reflex.*—This is a proprioceptive reflex obtained from the muscles of the neck and probably from the sense receptors of the ligaments and joints of the cervical spine as well. Turning the head to one side increases extensor spasticity on the side to which the face is turned (the face limbs) and increases flexor spasticity in the opposite limbs (the skull limbs). In the severe case of cerebral palsy the response is an immediate one—the face limbs extend and the skull limbs flex (fig. 5 a and b). In milder cases there may be delay owing to the lengthy latent period of this reflex—that is, the latent period is inversely related to the severity of the case. The effect is usually more clearly seen in the arms than in the legs, and sometimes can be seen only in the arms. It can often be more clearly demonstrated by an active movement of the child's head than by passive rotation. In some milder cases the reflex is present only when the child tries to do something difficult, or when he is excited. Sometimes it can be demonstrated only by testing the change of resistance of an arm to passive flexion or extension when the head is turned to one side and then away from it.

The asymmetrical tonic neck reflex (as.t.n.r.) may prevent the child from grasping an object while looking at it. In order to pick up the object, the child has to turn his head away from it. He also cannot bring his fingers to his mouth, because he can bend his elbow only when his head is turned away from the arm. Often his eyes are fixed towards the side to which the face is turned and he cannot look the opposite way or follow an object beyond the midline. The as.t.n.r. is usually stronger on the right side. Most children with a t.n.r. therefore, use their left hand. This is probably why many such children appear to be left-handed. An intelligent child, who learns to make use of the pattern of the as.t.n.r. for purposive activity in sitting, will in time add a scoliosis to the kyphosis described above. There is also an additional danger of a subluxation of the skull-leg.

The influence of the as.t.n.r. can be

seen in normal babies up to the age of 4 months. It is, however, very weak and shows itself only in the occasional assumption of the "fencing position",

Fig. 12—Total flexion in the kneeling position.

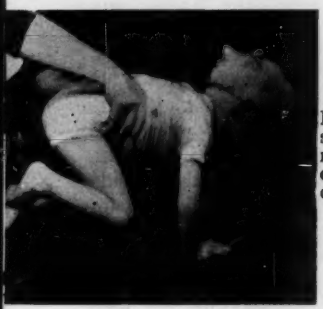

Fig. 13a & b—The symmetrical tonic neck reflex and its effect on the spastic child.

from which the normal baby can easily move away, whereas the child with cerebral palsy is stiff and more or less fixed in this position.

(*c*) *The Symmetrical Tonic Neck Reflex.*—This is also a proprioceptive reflex evoked from the proprioceptors of the neck muscles by an active or passive movement of raising or flexing the head. Raising the head produces an increase of extensor spasticity in the arms, and of flexor spasticity in the legs. Lowering the head has the opposite effect.

When a child with cerebral palsy is placed on his knees he usually shows a total picture of flexion and cannot extend his arms (fig. 12). However, if his head is passively raised he may extend his arms

Fig. 14.—Overaction of the symmetrical tonic neck reflex. With the head down, the arms flex, the legs extend, and the child slides forwards on to his face.

but his legs will be fixed in flexion, owing to the influence of the symmetrical tonic neck reflex (fig. 13 a and b). However, some children in whom the symmetrical tonic neck reflex is stronger than the tonic labyrinthine reflex cannot kneel with their head down, for their legs will then extend and their arms flex (fig. 14).

The severely affected quadruplegic child usually shows so much flexor spasticity when lying prone that he cannot get up to the kneeling position. In this case the tonic labyrinthine reflex dominates. The less affected quadruplegic and the diplegic children may get themselves into the kneeling posture by making use of the symmetrical tonic neck reflex pattern. They can, therefore, sit on their heels with the head raised and take their weight on the extended arms, but they cannot extend their legs to get to four-foot kneeling or move them alternately as in crawling. They may look fairly normal when sitting on their heels, but can only progress on their flexed legs by pulling them forwards with the help of their arms.

(*d*) *Associated Reactions.* — The associated reactions are released postural

reactions, and they produce a widespread increase of spasticity in all parts of the body not directly concerned with the movement. They are tonic reactions acting from one limb on the other (Walshe 1921). Associated reactions, sometimes called associated movements, can be seen in normal people when they take strenuous exercise—for instance, when lifting a heavy weight. In the quadruplegic patient the effort of moving one limb will increase spasticity in the rest of the body. If a hemiplegic patient squeezes an object with his sound hand, spasticity will increase in the hemiplegic side and will show itself in an accentuation of the hemiplegic posture (figs. 15 and 16). This means that in treatment one should not make the child use any one part of his body with effort, because in trying to improve the function of one part one may make the rest of the body worse. For instance, by trying to get extension of the spastic arm of a hemiplegic child one may increase the extensor spasticity of the spastic leg.

(c) *The Positive Supporting Reaction.*—The reaction is evoked by the twofold stimulus of (1) the ball of the foot touching the ground, and (2) pressure stretching the intrinsic muscles of the foot. As a result, muscle tone increases in both the flexor and extensor group of muscles of the leg, but more so in the antigravity muscles. This has been called co-contraction. The leg stiffens and becomes a rigid pillar of support. The effect persists as long as the two stimuli are active.

The spastic child walks on tiptoe, and as a result of the positive supporting reaction, spasticity increases every time the child puts his foot down. The child will therefore tend to fall backwards and the transfer of weight forwards over the standing position is made difficult.

Using This Knowledge

A knowledge of the individual reflexes is a great help in analysing the motor behaviour of children with cerebral palsy, and in recognising the influence of each postural reflex on the co-ordination of the child's postures and movements. Though isolated reflexes can rarely be seen, since the motor patterns observed are the result of a combination of reflexes acting simultaneously, certain distinct patterns of reaction which recur in the same circumstances can be traced to the dominating influence of one or the other single postural reflex.

It is comparatively easy to see this in the severely spastic patients who show released tonic reflexes most clearly. Such

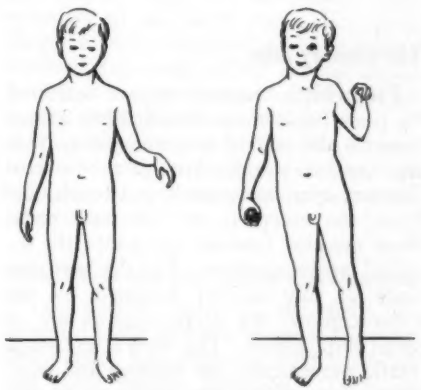

Fig. 15 & 16.—Associated reactions in a left-sided hemiplegic. Note accentuation of the hemiplegic posture produced by squeezing a small rubber ball in the normal (right) hand.

a patient can only learn to sit by himself if he has sufficient head control. This will enable him to strike a balance between flexor and extensor reflex activity (fig. 7). He can only learn to walk if his arms and trunk are less affected than his legs. He then can modify the extensor spasticity of his legs by thrusting his head and trunk forwards and by semi-flexing his hips and knees (figs. 10 and 11). He also will use his head and trunk to compensate for the lack of balance reactions in his legs and will use his hands for support.

In athetoid children tonic reflexes of varying strength appear only momentarily. They interfere with the child's voluntary movements.

In the less severe cases of athetosis and spasticity only traces of the typical tonic reflex patterns can be seen, because these children show more varied and adequate postural reactions and are capable of a great variety of voluntary movements. The abnormal reflexes proper usually cannot be elicited, but their combined influence can often be traced in the child's movement patterns. For instance, even a slightly spastic or athetoid child will walk with his legs inwardly rotated and will put his toes to the ground first.

The Sensory Side

From birth onwards we are activated by powerful afferent stimuli. They stream towards the central nervous system from the outside world, through the exteroceptors, eyes, ears, smell and touch, and from the receptors of our own body, from muscles, tendons and joints, the so-called proprioceptors. For the performance of any activity initiated by the exteroceptors, the proprioceptors are of great importance. The baby's first automatic movements, the righting and equilibrium reactions, are mediated by the proprioceptive system, which helps to lay down the sensorimotor patterns of our voluntary movements and skills. As Goody (1949) has pointed out: "We do not learn a movement but the sensation of a movement."

In the child with cerebral palsy the proprioceptive system can mediate only the sensations of an abnormal muscle tone and of abnormal postures and movements. It can therefore only serve to lay down abnormal patterns of posture and movement. The child will experience only the sensations of undue weight of his limbs and the excessive effort required for any intended movement. All he knows are a few abnormal postures and some abnormal movement patterns. With these sensory experiences he cannot be expected to develop normal movement patterns or a normal concept of his body.

For this reason, cerebral palsy should be considered a sensorimotor disorder rather than only a motor defect. Treatment should aim at changing this state by influencing and redirecting the motor output from the sensory side, using all means of sensory stimulation—proprioceptive, visual, auditory and tactile.

Treatment

Normal sensorimotor patterns can only be laid down on the basis of a normally functioning proprioceptive system. The first step in treatment is therefore to normalise muscle tone by inhibiting the released tonic reflex activity. The patterns of the tonic reflexes are broken up by using "reflex-inhibiting postures". The carry-over of treatment—that is, the permanent reduction of muscle tone and the inhibition of the intermittent spasms—can be obtained by activating the higher integrated normal postural reactions described above. These reactions are potentially present in most cases and can be activated and their patterns firmly established by repetition; that is, they can be "facilitated". They should be facilitated in their proper developmental sequence by using special methods of handling the child. Once these normal basic motor patterns are obtained and firmly established, they in their turn modify and weaken the tonic reflexes and keep them permanently in check. On the basis of the normal automatic movement patterns, the child can proceed to the learning of skilled purposive movements. The limitations of this approach lie in the potentialities of the child's damaged brain, and how far its remaining capacity can be utilized and reorganised in the most normal way. (For detailed descriptions of the techniques of handling, see Bobath and Bobath, 1952, 1953, 1954, 1956, 1957.)

Other Approaches to Treatment

The first specialised treatment of cerebral palsy has been developed by Phelps (1941, 1943, 1948, 1949), who has approached the treatment on orthopaedic

lines. His pioneer work has aroused interest in this neglected field and has helped and encouraged other workers, who in recent years have developed various treatment techniques based more on neurological lines. They look on cerebral palsy as a neuromuscular disorder rather than merely an orthopaedic problem. These new techniques have either been developed as an adjunct to orthopaedic treatment (Fay 1954), or have more or less moved away from orthopaedic procedures (Collis 1947, Kabat 1948, Knott and Voss 1956, Rood 1954).

"D." EARLY DIAGNOSIS

It is generally agreed that the early recognition of cerebral palsy is of great importance and that quicker and better results can be obtained from early treatment. If treatment can be started as early as 6 months of age the child has a better chance of improvement, for the following reasons:

1. The motor behaviour of the infant is largely reflex, and higher centres of the central nervous system are now only beginning to mature. At this stage the brain has more plasticity than later on, and its neural patterns can be influenced and changed more easily.

2. The infant very rarely shows appreciable degrees of spasticity, and the resistance of his spastic muscles does not yet interfere with his movements. Involuntary movements are rarely seen before the end of the second year. Normal movements can therefore more easily be facilitated and directed, and the onset of severe degrees of spasticity and involuntary movements may be prevented.

3. Early treatment may prevent the development of wrong patterns of movement and their habitual use for purposive activities. Contractures and deformities may be avoided and subsequent correction by orthopaedic measures may become unnecessary.

4. Mental retardation resulting from lack of sensory experiences may be avoided by giving the child a chance to move and use his limbs in a more normal way. Early treatment should be given to prevent mental retardation in a child of normal intelligence, and to avoid an additional deficit in the child with a possible primary amentia.

The early recognition of cerebral palsy is sometimes extremely difficult. The motor behaviour of the baby with cerebral palsy is usually a mixture of retarted development and pathological signs. Unless the case is severe the pathological signs are not usually pronounced at an early age. For early diagnosis it is important to have a good working knowledge of the normal child's motor development and the part played by the righting and equilibrium reactions in this development. One should also know the relevant tonic reflexes and their influence on the motor patterns of the brain-damaged child.

Some Facts in Early Motor Development

The normal baby in the first two months of life shows a preponderance of flexor tone. His limbs are held in flexion and resist passive extension. They are held tightly to the body, while the head ballots freely and is at first poorly controlled (Thomas and Dargassies 1952). The distribution of tone is strictly symmetrical, and any marked asymmetry of the newborn baby's motor behaviour must be looked on with suspicion. Head control improves rapidly, and after the first 3-4 weeks the baby starts to hold up his head when he is being moved and to lift it when he is lying prone. There is never the complete lack of control that we see in children with cerebral palsy, especially in those with cerebral flaccidity. At this early stage the baby shows the neck-righting reflex and Moro reflex (startle reaction).

Under normal circumstances extensor tone develops gradually from the 2nd month onwards. At about this time the baby raises his head when lying prone and he gradually extends his spine against

gravity. Later on, from the 6th month onwards, he will lift his buttocks off the support when lying supine, supporting himself temporarily on his shoulders and feet only, thus exercising the extensor muscles of his trunk and neck.

The influence of tonic reflexes can be observed in the normal baby up to 4-6 months. The influence of the asymmetrical tonic neck reflex can occasionally be seen when the baby is at rest; he may lie with his head turned to one side, with the arm on that side extended and the other flexed. This attitude can be seen clearly from the 5th week onwards, when the initial symmetry of motor behaviour changes and when the preponderance of flexor tone gives way to increased activity of the extensors. At 4 months of age, when the influence of the asymmetrical tonic neck reflex has disappeared, the baby again assumes more symmetrical postures and is ambidextrous. In the normal child tonic reflex activity is never strong and does not interfere with the child's movements.

Motor Development of Brain-Damaged Children

The baby with cerebral palsy also shows at first a preponderance of flexor tone and only when extensor tone develops will he show spasticity. The speed development of spasticity, as well as its degree, depends on the severity of the case. The tonic reflexes, instead of disappearing at 4 months of age, gradually gain in strength. At first they may be seen only intermittently, and they then produce the "dystonic attacks" mentioned above.

When trying to make an early diagnosis one should look for the earliest signs of tonic reflex activity. Early diagnosis is usually not difficult in severe cases, when spasticity and tonic reflex activity are strong and show themselves clearly. But diagnosis is often difficult in the milder cases when these signs develop insiduously and slowly and never become very clear. In such cases the signs must for diagnostic purposes be looked for by special tests. In most cases it is difficult to predict at an early age what type of cerebral palsy the baby is likely to develop later, and one may have to be satisfied with an unspecific diagnosis of brain damage.

Description of Tests

None of the single tests which will be described is by itself more than a pointer towards the diagnosis. The certainty of brain damage is in direct relation to the number of tests found to be positive. They should be thought of as an adjunct to the usual examination techniques, and should be used in conjunction with the customary paediatric and neurological examinations. (The summarised descriptions given here can be supplemented by consulting the papers of Thomas and Dargassies 1952, Illingworth 1958, and Bobath and Bobath 1956.)

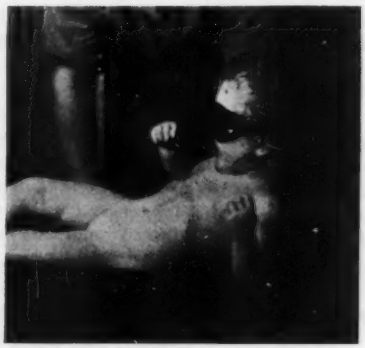

Fig. 17.—Position of maximal extensor spasticity.

1. Tests in the Supine Position, the Position of Maximal Extensor Spacticity

The examiner places his hand behind the baby's head and lifts him up towards the sitting posture. Resistance of the head and neck may be felt, and the arms, instead of moving forwards and across the chest, will retract at the shoulders (fig. 17).

The examiner grasps the child's elbows and moves them forwards and

across the child's chest. Resistance to this movement can be felt and the arms pull backwards. When the baby's arms or hands are held and he is pulled up to the sitting position, his head may retract, and in the more severe cases the hips may resist flexion. The child may even arch his spine backwards and remain fully extended, resting with his feet on the support (fig. 18).

Fig. 18.—Note resistance of hips to flexion and retraction of head.

The baby with cerebral palsy shows abduction of the arms with retraction of the shoulders and flexion of the elbows, when lying on his back. If his head is turned to one side, or, better still, if he turns his head actively to the side, the face-arm may extend while the skull-arm flexes (asymmetrical tonic neck reflex). In the severe case the response may be immediate, and it may be delayed or absent in milder cases. In some milder cases the change of muscle tone produced by the asymmetrical tonic neck reflex can be detected only by testing the resistance of the arm to flexion and extension while turning the head first to one side and then to the other. This test will also show the retraction of the shoulder of the skull-arm, which prevents the baby from turning on his side or into the prone position. This shows the inhibition of the neck-righting reaction by extensor spasticity.

Extensor spasticity of the legs can be demonstrated by grasping the baby's legs below the knees and moving them quickly up to flexion. The resistance to this movement is a measure of the degree of spasticity. If the legs are released they extend, adduct and sometimes cross. To detect early and mild degrees of adductor spasticity, the legs should be extended and rotated inwards (the total extension pattern) and then quickly moved apart.

The flaccid baby usually shows a flexion—abduction pattern of the legs. They are flexed at all joints, widely abducted, and rotated outwards so that the outer aspect of the thigh touches the support, a position not unusual in premature babies. If one tries to extend and adduct the legs there may be resistance, and when the legs are released they return to the flexed position.

II. Tests in the Prone Position, the Position of Maximal Flexor Spasticity

When placed on his abdomen, the normal baby will turn his head to one side. This is a protective reaction, present at birth, which keeps the baby's air-passages free. This reaction is often absent in the child with cerebral palsy. Moreover, he cannot raise his head and therefore dislikes lying prone. In this position his spine is flexed, his arms are bent and adducted, and his hands are often caught under his chest (fig. 6). If the examiner grasps the baby's hands, and tries to move them upwards so as to place the extended arms beside the head, resistance will be felt. When released the arms will return to the original position of flexion and adduction.

When the child's head is lifted, supported under the chin, downward pressure of the head may be felt, and the arms will pull up in flexion (fig. 19). The reaction of a normal baby from the 4th month onwards is a protective extension of the arms with the hands placed on the table.

It may be impossible to place the child on his abdomen if flexor spasticity is very strong and the child cannot extend his hips. However, if his hips can be extended, his legs may also extend, and

they may even become spastic in extension while the spine, neck and arms remain flexed.

When the baby's hips are lifted off the support, the pelvis being held at the iliac crests, the legs may remain stiffly extended and it may be difficult to flex them passively (fig. 20). If the legs bend they do so slowly and after considerable delay. The normal baby bends his legs immediately when tested in this way.

Fig. 19.—Downward pressure of the head and drawing up of the arms.

Fig. 20.—The legs remain stiffly extended and resist flexion.

Extensor spasticity of the legs can also be demonstrated by bending the child's knees and holding the hips down on the support. This should be done with adducted legs, for extensor spasticity is stronger and more easily demonstrated in adduction. The knees will then resist passive flexion. If the hips are released, flexion of the knees will be less resisted, but the hips will flex as well (fig. 21).

Fig. 21.—Passive flexion of the knee results in simultaneous flexion of the hip.

When the baby is held free in the air, face downwards and supported under the lower chest, he will neither right his head nor extend his spine and hips. His head, neck, spine and hips will remain flexed, his arms being drawn up in flexion. Only the knees may be extended if extensor spasticity is marked (fig. 22). The normal baby, tested in this position, will right his head and extend his spine and hips from about the 6th month onwards. This is the "Landau reflex". It is usually absent in children with cerebral palsy.

Fig. 22.—Inability to right the head and extend the body.

When the baby is lowered from the above position, with his head downwards, the cerebral palsied child will not stretch out his arms but keep them drawn up in flexion. The normal baby, from the age of 6 months onwards, extends his arms and hands to suport himself (fig. 23).

Fig. 23.—Absence of "Sprungbereitschaft".

III. Tests in the Upright Position

Extensor spasticity of the legs can be detected by holding the child up in the air supported under his arms. He is then slowly lowered towards the support. The legs may then extend and adduct and the feet point downwards (fig. 24 a and b).

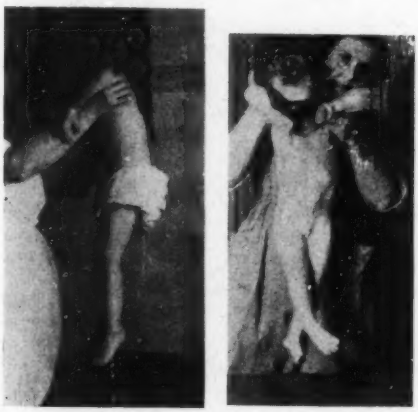

Fig. 24a & b.—Pointing of the feet and occasional crossing of the legs.

When his feet touch the ground the child will stand on his toes, with his legs spastic in extension. If extensor spasticity is moderate the child may show reflex-stepping. The normal baby when tested in this way will keep his legs rotated outwards and abducted and his feet dorsiflexed, while he extends his hips and knees.

IV. Tests for the Moro Reflex and the Plantar Response

The Moro reflex or "startle reaction" is a normal reaction of infants up to the age of 6 months to various stimuli, such as moving or tapping the supporting surface, sudden passive extension of the legs, and tapping the abdomen. It consists of abduction and extension of the arms and opening of the fingers from their original flexed posture. In the normal child this reaction has disappeared at 6 months of age, but it often persists in children with cerebral palsy (fig. 25). It is seen most clearly in positions which favour extensor spasticity—for instance, in the supine and sitting positions when the child is tipped backwards.

Fig. 25.—The 'Moro' reflex.

In normal circumstances, the extensor plantar response (Babinski response) of the baby is said to disappear at about 18 months. However, all the baby's responses, including the extensor plantar response, are characterised by their variability. Peiper (1956), citing Richards and Irwin, describes seven possible reactions of the baby to the stimulus evoking a plantar response:

1. Flexion of all toes.
2. Extension of the big toe alone.
3. Extension of one or all of the small toes.

4. Flexion of one or all toes.
5. Mixed reactions (extension following or preceding flexion).
6. No response.
7. Uncertain response.

It therefore seems that a constant and unequivocal extensor plantar response is a sign of abnormality even before the age of 18 months.

Assessment of Severity

The strength of the released tonic reflexes is a direct indication of the severity of the condition. In a severe case of cerebral palsy these reflexes occur regularly and are instantaneous and unmodified. They leave little or no possibility for normal automatic or voluntary movement. In moderately severe cases the tonic reflexes are not constant and can only be seen in positions most favourable for their occurence. Their action is usually delayed and appears only under strong stimulation, when the child is excited, or when he attempts to do something difficult. In these cases some righting and equilibrium reactions are present, and some of the simpler voluntary movements can be performed, though they are interfered with by abnormal reflex activity. In mild cases only traces of tonic reflex activity can be seen, and more when the child attempts difficult voluntary movements than in simple and more automatic activities. Righting reactions are usually present, and the equilibrium reactions of earlier stages of development are usually well developed, while the later and more complex ones in standing and walking are faulty.

SUMMARY

The condition known in the Anglo-Saxon world as cerebral palsy is defined, and its aetiology, incidence and classification are briefly surveyed. The neuropathology is described in detail.

Cerebral palsy is caused by a lack of inhibitory control, leading to a disturbance of the postural reflex mechanism, with release of the tonic reflexes of Magnus and de Klejn. The relevant reflexes and their influence on the motor behaviour of the child with cerebral palsy are described, and their value for early diagnosis and assessment is stressed.

Treatment should be approached on neurological lines, the aims being to inhibit abnormal reflex activity and facilitate normal automatic reactions.

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Erratum: Several errors in the references of this paper were noted too late for correction but will be put right in Dr. Bobath's reprints.—*Ed. C.P. Bulletin.*

New Zealand's Spastics Fellowship

The "*Cerebral Palsy News*", quarterly journal of the New Zealand Spastics Fellowship, is now starting its second year of life. The basic objects of the Fellowship are "To bring the cerebral palsied people of New Zealand into the community and enable them to live as full and happy lives as possible"; and "To give help and information to those who need it". In a brief but to-the-point article on *The Place of the Residential Unit* in the management of cerebral palsy, Dr. B. S. Rose, medical superintendent of the Queen Elizabeth Hospital in Rotorua, tells us that the cerebral palsied in New Zealand number only a few hundred, but each is as he is for life, and a big slice of the nation's total man-years of disability is always potentially theirs.

The little magazine provides all the evidences of vitality which those who see a lot of journals learn to recognise. The main editorial emphasises the need for more sharing of knowledge on this wide subject: "Unless there is intercommunication and discussion, exchange of views on problems and progress, among those actually working professionally with the cerebral palsied, the endless road of struggles is only made rougher and harder because of trial and error everywhere." Plans are being made for an "eminent overseas authority" to visit New Zealand in 1960. Such a visitor should give the people working with cerebral palsy in New Zealand an extra impetus and a renewed inspiration in their work.

The editor is Miss Paulette A. Leaning, Rocklands Hall, 187 Gillies Avenue, Epsom, Auckland, New Zealand, and the annual subscription is five shillings.

The Neurological Department of the District Children's Hospital in Brno

IN the past summer I visited Brno, second largest city of Czechoslovakia, with a population of 300,000. The city is nicely situated in the central part of the country, and has a university with a medical faculty. My sojourn there was brief, so I can give only some superficial impressions of the medical centre which I visited, and I shall confine myself to some of the things which particularly struck me, my special interest being in child neurology.

The District Children's Hospital is a medical centre for patients up to the age of 15, with departments for the various special disciplines such as internal medicine, surgery, orthopaedics, otorhinolaryngology, ophthalmology, dermatology, infectious diseases, radiology, neurology, psychiatry and physiotherapy. The hospital has some 760 beds, available to patients from a large district surrounding the city. Its outpatient clinics are crowded. It is the first centre of its type in Czechoslovakia, and it affords training facilities in paediatrics for both medical undergraduates and psychological students*.

Dr. Toman, head of the Internal Department, told me that Czechoslovakia has a training programme for general practitioners (6 years' theory and 3 years' practical study) and one for paediatric practitioners (6 years' theory and 2 years' practice), who can either set up practice as family physicians for children in the country districts or continue specialized study.

The hospital buildings are partly old and partly new, its organization still being under development. In the newly constructed part, where I visited the orthopaedic department, there are small wards, with large well-lighted corridors and operating rooms. The psychiatric department has so far consisted only of an outpatient clinic. Children with psychiatric disorders requiring hospitalization are referred to the University Hospital or the Neurological Department of the District Children's Hospital. The latter has an outpatient clinic with a monthly attendance of over 1000 patients, and a 31-bed clinic situated in an old but in no way derelict building. There are plans for building a new clinic in a few years' time.

In the Neurological Clinic, I twice accompanied the department head, Dr. V. Holub, on his early morning rounds of the wards (at 7.30 a.m.). His two medical assistants work in the Clinic and in the outpatient department, while a chief assistant is responsible—among other things—for consultations in the other departments. On his morning rounds the department head is accompanied twice weekly by an E.E.G. specialist, a psychologist and a school-teacher—all permanent staff members. This department has 6 small wards, each accommodating 4-6 beds. One room with blue walls and subdued lighting was set aside entirely for chorea patients (mostly chorea minor), who were given a regimen consisting of rest and the admini-

stration of bromides and barbiturates.

In another ward we saw a few patients with demyelinating conditions, including one with an affection resembling Schilder's encephalitis; three other patients showed a clinical picture resembling that of subacute sclerosing leuco-encephalitis, as described by Ludo van Bogaert. The typical extrapyramidal jerks and the stuporous terminal phase, with the flattened E.E.G. were as dismal a sight as one would see anywhere.

There was one patient with Bell's palsy in the hospital for C.S.F. examination to verify poliomyelitis or some other infection, possibly leptospiral. I was told that there had been numerous cases of infectious cerebral diseases some years ago, which were found to have been spread by tick-bites. I saw one patient at the outpatient clinic with paresis of the biceps as a sequel to such an infection,.

Some cases of cerebral palsy were in the hospital for an exhaustive examination before being referred to a rehabilitation centre.

There were some probable cases of myopathy, including a typical limp child showing clinical features reminiscent of Oppenheim's amyotonia. I also saw children with so-called degenerative diseases, such as Friedreich's ataxia, and of course numerous cases of epilepsy, receiving treatment on rather the same lines as in the Netherlands.

One boy with a pronounced tic was having Largactil, and a girl with cephalalgia awaited medical and psychological examination. In this connection Dr. Holub told us: "As a child neurologist, I could not possibly work without a psychologist". And cooperation with the psychologist does indeed seem to be very important here, not only to extend the diagnostic possibilities (one paper published from this clinic elucidates the difference in psychological behaviour between a child with a brain tumour and one suffering from a demyelinating disease[1]), but also for psychotherapeutic purposes.

There is a school on the premises, and the school-teacher appointed to the department of child neurology (a doctor of philosophy) assists the little patients in their learning difficulties.

The E.E.G. apparatus (a Danish "Kaiser") is available to the entire hospital and to the outpatient clinics. Methods of provocation employed include hyperventilation, photo-stimulation and megimide injections.

Considerable emphasis is placed on physiotherapy. This department is in the new part of the hospital, where all types of baths are available. Such conditions as muscular dystrophy are treated by iontophoresis with glycocol for 4-5 hours. Exercise and massage are given after the preparation of stiff limbs with hot baths or packs. A large institute, where some 500 children are given their weekly exercises and baths, has a school for 25 scoliotics; the children lie prone, doing school-work for half their day and having physical training in the other half.

With regard to the publications of Dr. Holub, our impression is that Czechoslovakian child neurology is in full development. The knowledge of foreign medical literature is extensive. Ford's "Diseases of the Nervous System in Infancy, Childhood and Adolescence" is used as a manual at the Brno Clinic. In the past three years there have been annual national meetings of child neurologists.

C. J. VAN DER GAAG.

Groningen.

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1. Holub, V. and Svancara, J. "Die Mitarbeit des Psychologen an der neurologisch-psychiatrischen Kinderabteilung." *Z. Psychol.* 1957, 161, 296.

BOOKS—NEW AND NOT SO NEW

The Borderland of Embryology and Pathology

R. A. WILLIS, D.Sc., M.D., F.R.C.P.

London. Butterworth. 1958, *pp.* 627, *with* 224 *illustrations.* £4 10s.

DISEASE is the result of a chain of causative factors. In earlier times the emphasis was mainly laid on the constitutional weakness of the individual. More recently—notably since the discovery of pathogenic micro-organisms—the factors that enter the body from outside have occupied the centre of attention. It was soon realised, however, that what is decisive in the coming into being of disease and its course is the response of the individual. This is genetically determined. Disease and malformation are therefore more intimately related to each other than was at one time thought. Hence the importance of embryology in the understanding of disease. The significance of embryology in the study of tumours was brought out some 150 years ago through the work of such men as John Hunter, Abernethy, Johannes Müller and his pupil Robert Remak, and later Julius Cohnheim. This was the time when the cell became recognised as the elementary unit of all tissues and the essential seat of the life process in health and disease. Since then, embryology has grown out of all proportion. It has become possible to use the animal embryo as an "experimental animal" and thus, since the discoveries made in this way by Spemann and his school, new perspectives have been opened up in cellular physiology and pathology—through embryology. One example is the lesson learnt from Spemann's work on the "organiser" in the interpretation of the large group of tumours called "Teratomata," the organiser being the germ of the fundamental axial structures of the embryo, which when grafted into the front or side of another embryo will "induce" the neighbouring host tissues to form a secondary embryo in the host.

Hence, a juxtaposition of pathological and embryological data in itself meets an urgent demand on the part of biologists and pathologists, and no praise can do full justice to the clear and concise account given in this book. But it is much more than a mere synopsis of embryological and pathological facts. Its main value lies in the critical discussion and reduction of the vast literature to a few general conclusions, mostly given at the end of the chapters. Here the author stresses the functional point of view emerging from the morphological material. In this respect such highly involved and important topics as the inborn metabolic and allied disorders and the transplantation and culture of tissues should be particularly mentioned. Those degenerative disorders of the nervous system that are not congenital but are first manifested at some stage of postnatal life—the heredo-familial "abiotrophic" nervous diseases—as well as the muscular dystrophies and inborn errors in skeletal structure and function, are discussed with the inborn metabolic disorders. The final chapter, *Suggestions for Research,* is a spring of inspiration.

In this work, as in Willis's *Pathology of Tumours,* narrative and argument are largely based on original material and always helpful and stimulating personal judgment. Dr. Willis has created a new classic in pathology.

W. PAGEL.

RECENT ADVANCES IN PAEDIATRICS

Edited by Dr. Douglas Gairdner, F.R.C.P., 2nd ed. *London: J. & A. Churchill*, 1958, *pp.* 378, 48s.

The first edition of *Recent Advances in Paediatrics* was published in 1954 and proved to be a very welcome British publication. The second edition, under the same editor, maintains its high standard. The material for the 13 chapters is entirely different from that in the first edition, even though one of the subjects, "Tuberculosis," occurs in both.

All the chapters have been written by experts who have done a great deal of work to bring the various subjects right up to date for the reader; and for those who want more there are many references.

The first 4 chapters concern aspects of foetal and infant life, starting with a stimulating journey into animal and human physiology — "Changes in the Circulation at Birth and the Effects of Asphyxia". Then there is an interesting chapter on "The Haematology of Infancy" by the editor, who has spent a lot of time on this subject. After that come two chapters on "Jaundice in the Newborn," an extensive subject well presented. The next chapter, on "Physical Growth," reveals the increasing momentum of research in this field; there will certainly be more to tell in the future —perhaps in the next edition. The chapter on "Hypothyroidism" gives further evidence of advance by new methods of investigation, so that what was a comparatively simple subject has acquired a fresh aetiology.

The next two chapters, "Spina Bifida Cystica" and "Hydrocephalus of Infancy", are most timely; the thread of life has been made so much stronger by modern drugs that more such children survive and present a challenging problem to parents and doctors. Another condition which has taxed the ingenuity of all doctors is described in the chapter on "Nephrosis;" perhaps the steroid therapy outlined here will become the most powerful weapon in our armoury.

"Tuberculosis" and "Rheumatic Fever" are the next subjects, and the reader is told the latest news about the natural history and treatment of these conditions, both chapters ending with many useful references. While these two disease processes are diminishing other problems become more prominent, and one such problem is "The Deaf Child"; this chapter is full of interest and helpful to all.

Finally there is a chapter on "Pyogenic Osteitis," telling of the better prognosis since the advent of penicillin, emphasising the importance of early diagnosis, and warning us that not all staphylococci are frightened of penicillin, especially in neonatal life.

Those interested in cerebral palsy will remember that the first edition contained a chapter on this subject; but they will find plenty to interest them in this edition —for example, the physiology of foetal and neonatal circulation, kernicterus, the handicaps of the child with spina bifida and hydrocephalus, and the deaf child. Dr. Douglas Gairdner is to be congratulated on his team and the result. This is an excellent book which should find its way into all our libraries.

J. F. P. QUINTON.

The History and Philosophy of Knowledge of the Brain and its Functions

Edited by DR. F. N. L. POYNTER, PH.D., F.L.A. *Oxford*: Blackwell. 1959, pp. 284, 22*s*. 6*d*.

This volume contains the papers given at a symposium held at the Maudsley Hospital, London, in July, 1957, and sponsored by the Wellcome Historical Medical Library. Many of the leading British and American neurologists and cerebral physiologists took part.

It is a pleasure to read a book that achieves such a high level of quality. Not

only are the contributors individually of the highest authority, but their contributions cohere, to form an integrated whole, to a degree quite unusual in such symposia.

Our ideas about the brain, in its interaction with its environment, are today in a state of flux, as we change from the older metaphysical concepts, which were a heterogeneous collection of varied origins, to the unifying concept of the brain as a regulator which uses information. The relation of the old concepts to the new is sometimes obscure; understanding of this relation may be helped if one knows how the old concepts arose, so as to see something of their real *operational* content.

By discussing the actual origins and contents of the old concepts, this book throws a valuable light on their real, pragmatic, operational contents as distinct from their arbitrary verbal representations.

This is a volume worth keeping and reading at length.

W. ROSS ASHBY.

The Cranial Nerves

ALF BRODAL, M.D. *Oxford*: Blackwell. 1959, pp. 141, 15*s*.

Professor Brodal's great interest in the central nervous system is well known; his important work in this field, especially on the cranial nerves, is quoted in every textbook on neuro-anatomy.

This book is the English version of his "hernenerverne", printed in 1957, though some data from research done since then have been included. In this monograph Professor Brodal gives an excellent description of the cranial nerves, covering not only the central parts but also the peripheral parts of the nerves, with their structure, functions and dysfunctions, and he integrates the anatomy, physiology, and function with the clinical aspects. A lot of details, and information drawn from anatomical and physiological research done in the last year, are mentioned briefly. The monograph is well written, but it is not easy to read—it is heavy stuff and lays facts upon facts. To my opinion, however, this is an outstanding work: I have read about the cranial nerves in numerous textbooks but I much prefer to read about them in this monograph.

The various cranial-nerve palsies and dysfunctions found in cerebral palsy compel the paediatrician, the psychiatrist, the orthopaedic surgeon and the other medical men and women dealing with cerebral palsy to be well acquainted with the cranial nerves. This monograph can be highly recommended to them all.

ERIK HANSEN.

The Birth of Normal Babies

LYON P. STREAN, PH.D., D.D.S.

London: *Vision Press*, 1959, *pp.* 190, 21*s*.

The author who is a scientist and not a medical graduate, has studied the antenatal history and background of a large number of women who have produced abnormal babies.

As a result of this work and of his personal experiments with animals, he believes that physical and mental stress are common causes of foetal abnormality, when experienced by the mother during the first trimester of pregnancy. It is suggested that this effect is produced by increased secretion from the suprarenal cortex at the time of the stress, and corroborative evidence is offered from the results of experimental trauma and the injection of cortisone into pregnant mice.

With this hypothesis as his principal theme, Dr. Strean sets out to tell the prospective mother and her relatives how stresses may occur during pregnancy and how to prevent them or mitigate their effects.

With the growing recognition of the importance of environmental causes of foetal abnormality, many of the author's comments may be seen to contain more than a grain of truth. Many of his conclusions, however, seem to be based on flimsy evidence and are likely to cause unjustifiable anxiety if the book is read by an expectant mother. Thus a case of congenital cardiac malformation is attributed to the mother having taken a nightly barbiturate sleeping tablet. Foetal malformations following maternal whooping-cough, dental and oral sepsis and penicillin allergy are among the many cases described without any indication to the lay reader of the statistical likelihood of such a sequence of events occurring by chance. "A variety of congenital defects", including mental retardation and mongolism, are said to be the possible consequences of gonorrhoea during the first trimester.

The figures quoted for the chance of foetal abnormality recurring in successive pregnancies seem at variance with those usually quoted elsewhere, and, the brief reference to Rhesus iso-immunisation leaves one with the impression that the second rhesus-positive infant is invariably affected.

Instances are given, quoting case-histories, of how the author cnosiders that stresses might have been avoided. Apart from advice on diet in pregnancy and the value of active and passive immunisation, the principal prophylactic measure is the administration of vitamin B6, which is alleged to counteract the katabolic effect of the excess of cortisone.

There are numerous repetitions in the text of this book, and the arrangement of some of the subject matter seems confused; for instance, a chapter entitled "Physiologic Stress" contains a miscellany of case-histories ranging from alveolar abscess to allergy and includes a discussion on venereal disease.

The book contains some interesting speculation, the advice on diet and immunisation is sound so far as it goes, and the warnings on the danger of cortisone therapy and the abuse of X-rays during pregnancy may be timely. The amount of useful information for prospective or expectant mothers, however, is so outbalanced by misleading and sometimes ill-informed comment that one would hesitate to recommend this book for the purpose for which it was written.

S. D. PERCHARD.

Prof. Henri Gastaut, of Marseilles, has reprints available from the series of articles on various aspects of the epilepsies, published by himself and his collaborators in 1950-1958. A list of these reprints is obtainable from: Laboratorie de Neurophysologie Clinique, 38 Boulevard Longchamp, Marseille, 1.

ABSTRACTS

IN COLLABORATION WITH "*Abstracts of World Medicine*," PUBLISHED BY THE BRITISH MEDICAL ASSOCIATION

The Neurological Examination of Infants

S. KUPERNIK. (*In Russian*). *Z. Nevropat. Psihiat.* 1959, **59**, 808–815.

The usual methods of neurological examination are not suitable for use in children under one year of age, since they are based on the normal development of the central nervous system at a later stage, and moreover at this age the young infant cannot cooperate to assist in the examination. It should be remembered that signs which at an early age are normal may be pathological in a child a few months older, since the CNS is undergoing rapid evolution.

The examination of the infant therefore is based on the primitive automatisms which govern the normal CNS at that age. Earlier workers have emphasized the value of the Moro reflex, which is best elicited by raising the child by the legs without moving the head from the pillow; a response consisting in extension and abduction of the arms followed by their return to the mid-line (the so-called "embrace reflex") is the normal reaction to this movement in the first 8 weeks of life, but its persistence after the 6th month is evidence of severe damage to the CNS

The same is true of the "extension reflex", in which the child is held by the examiner under the arms and raised to a standing position with the feet pressing on the floor or bed; this should produce a progressive extension of the body, first of the lower extremities, then of the trunk, and lastly of the neck. So also with the "stepping reflex", in which the child is again supported in the standing position with the body leaning slightly forward, whereupon it makes automatic stepping movements unassociated with any ability to balance itself or with any movements of the upper limbs. Likewise, the "prone crawling reflex" and the "grasping reflex" should disappear between the 4th and 6th month, soon to be replaced by purposeful movements in which all the limbs take a part.

Further examination of the infant should include a test for muscle tonus, especially in the muscles of the wrist, forearm, and neck. Passive turning of the head from side to side and of the wrist on the forearm is most valuable in eliciting evidence of diminished or excessive tonus. Next, the posture of the child as a whole should be carefully studied. A child under the age of 4 months cannot maintain itself in the sitting position, but should be able to support its head when lifted into that position; at 6 months it can support itself with the help of its arms, and at 8 months should be able to sit unsupported. At the latter age, if stood upright, it protrudes the buttocks and cannot stand unsupported, because the normal spinal curves have not yet developed, these appearing about the end of the first year. Raising the child by the arms with its feet braced against a block will reveal its power to support the head, which it should be able to do at the 6th month.

Of these postural-locomotor reflexes one of the most valuable is the "diving reflex". This is elicited by raising the child horizontally in the prone position, and then quickly bringing it down towards the bed with the head tipped downwards and forwards, as in diving; to this manœuvre an infant of 2 months will respond by flexing the elbows, but between the 8th and 10th month the normal child will extend its arms with hands forwards, as though to protect its head. This reflex precedes the ability to walk, and its

absence at 8 to 10 months is significant of cerebral damage or defect. Lastly the response of the eyes to sideward and rotatory movements of the head or to light, the presence of nystagmus, the response to sounds, and the power to imitate the movements of adults (for example, smiling) are all phenomena which indicate the state and development of the sensory system and of the power of the child to respond to its environment.

L. Firman-Edwards

An Analysis of the Causes of Perinatal Death

J. R. MITCHELL, G. HOGG, A. J. DEPAPE, J. N. BRIGGS, and H. MEDOVY. *Canadian Medical Association Journal* May 15, 1959. **80**, 796-799.

At the Winnipeg General and St. Boniface Hospitals, Winnipeg, between April 1, 1954, and March 31, 1958, there were 25,863 live births and 333 stillbirths (excluding cases in which the infant weighed less than 750 g. at birth); of the babies born alive, 374 died within 7 days of birth, making the total of 707 perinatal deaths. The perinatal mortality during the period was thus 26·9 per 1,000 total births. Post-mortem examinations were performed in 668 (94·5%) of the 707 cases, the remaining 39 being excluded from analysis even though there was an obvious associated clinical factor in most of them. In 520 of the 668 cases a single major pathological finding at necropsy allowed a definite diagnosis of the cause of death to be made. The results are listed according to the main headings of the International Classification of Diseases and Causes of Death as follows:

Cause of Death	Perinatal No.	Perinatal %	Neonatal No.	Neonatal %	Stillbirths No.	Stillbirths %
Anoxia	164	23·6	51	13·6	113	33·9
Abnormal pulmonary ventilation	101	14·2	101	27·0	0	—
Congenital malformations	93	13·1	48	12·8	45	13·5
Infection	69	9·7	54	14·4	15	4·5
Haemolytic disease of newborn ...	36	5·0	22	5·9	14	4·2
Trauma	33	4·6	24	6·4	9	2·7
Immaturity ...	7	0·9	5	1·3	2	0·6
Miscellaneous ...	17	2·4	14	3·7	3	0·9
Inconclusive ...	18	2·5	18	4·8	0	—
Unknown ...	130	18·4	15	4·0	115	34·5
No necropsy ...	39	5·5	22	5·9	17	5·1
Total	707	99·9	374	99·8	333	99·9

Of the 130 cases in which there were no significant findings post mortem, in 20 (5 neonatal deaths and 15 stillbirths) there were major clinical factors such as maternal toxaemia or diabetes which permitted death to be attributed to maternal disease. In another 51 cases (3 neonatal deaths and 48 stillbirths) there were minor clinical factors which might have resulted in foetal death, no other cause being found; these factors included twin pregnancy, cord complications, mild maternal toxaemia or other illness, minor antepartum haemorrhage, possible intra-uterine foetal bleeding, and circumvallate placenta. In the remaining 59 cases (7 neonatal deaths and 52 stillbirths), forming 8·8% of the cases studied post mortem, pregnancy had been normal and no cause of death could be found. This group was compared with a control group selected at random from among the normal and premature babies discharged alive from the two hospitals in respect of maternal age, length of gestation, and history of previous abortion or stillbirth. No significant difference was found, although a history of previous abortion or stillbirth was slightly more common than in the controls.

Premature births formed 5·4% of all live births during the period, the rate rising yearly from 4·1% in 1954-5 to 6·0% in 1957-8. The proportion of stillbirths which were premature remained around 51%, but the proportion of premature babies among those dying in the first week of life rose from 66% in 1954-5 to 80·4% in 1957-8.

Janet Q. Ballantine

The Physiognomic, Psychometric, Behavioral and Neurological Aspects of Phenylketonuria

F. E. KRATTER. *Journal of Mental Science* April, 1959. **105**, 421-427.

Of 1853 patients in a mental deficiency institution, 12 (5 male and 7 female) had phenylketonuria. In 9 of the patients the I.Q. ranged from 4 to 17 and in 3 from 20 to 37; their ages ranged from 9 to 38 years. All except one of the patients had blue irises and a similar number had blond hair; 8 had a pale skin. Hyperkinetic distractibility, lack of rapport, mischievousness, motor perseveration, echopraxia, and

a short-lived span of attention were observed in 11 patients and stereotyped posturing, grimacing, and mannerisms in several. Affective tone was blunted. The cheerful, self-centred behaviour was apt to change suddenly to short bursts of noisy restlessness, aimless destruction, or crying and laughter devoid of emotion.

Of 59 siblings of the patients, 19 were known to be mentally defective. The family history in all 12 cases was unsatisfactory. The patient first walked at 6 years in one case, at 5 years in 2 cases, and at 2, 2¼, and 3 years respectively in 3 others; in 3 the age at onset of walking was not known, and 3 patients were unable to walk. Eight of the patients were mute; of the remainder, 2 began to speak at the age of 4 years and 2 at 6 and 7 years. Little's syndrome was present in one case, Parkinsonism in one, and cerebral palsy with choreo-athetosis in one.

G. de M. Rudolf

An Epidemiological Study of Congenital Malformations in New York State

J. T. GENTRY, E. PARKHURST and G. V. BULIN. *American Journal of Public Health* April, 1959. **49**, 497-513.

An investigation is reported of the incidence of congenital malformations in children born in New York State (excluding New York City) between 1948 and 1955 and the relationship, if any, to the distribution of natural materials of relatively high radioactivity.

A total of 16,369 malformations were reported in birth and death certificates during the period, a rate of 13·2 per 1,000 live births. Exceptionally high rates, up to 20·0 per 1,000, were noted in 186 of the 942 townships, especially in certain contiguous areas on high ground. From an examination of geographical and geological data it was possible to define areas with deposits of materials of high radioactivity. The incidence of congenital malformations was greater (15·8 per 1,000 live births) in areas with high levels of natural radioactivity than in rural areas with low levels (12·9 per 1,000). Further, the incidence of malformations in areas of "probable" radioactive materials was higher in communities using water from wells and springs than in those in the same areas using surface water. Measurement of external radiation in areas close to exposed radioactive mineral showed that this was 30 times higher than normal.

Since no other factors were found to be responsible for the varying incidence of congenital malformations, the authors conclude that it is significantly related to local levels of radioactivity.

[This important paper requires confirmation from other parts of the world.]

John Fry

Protein Metabolism of the Brain

D. RICHTER. *British Medical Journal* May 16, 1959. **i**, 1255-1259.

The author, working at the M.R.C. Neuropsychiatric Research Unit, Whitchurch Hospital, Cardiff, surveys the recent findings on this subject.

The growth of the brain proceeds ahead of most of the other organs of the body; thus in the embryo of 5 days the brain accounts for as much as 30% of the total body weight, this rapid increase in weight being due to the active synthesis of new protein. Experiments *in vivo* to determine the rate of incorporation into the proteins of the brain of amino-acids labelled with radioactive isotopes and introduced directly into the cerebrospinal fluid have shown that this rate is considerably higher in the newborn animal than in the adult, and that it gradually diminishes with increasing age. The increase in protein concentration occurs later in the cerebral cortex and cerebellum, which are phylogenetically more recent and the last to become functionally active. This process of growth is accompanied by morphological changes as well as by changes in enzymatic activity. When growth ceases many enzyme systems, such as those concerned in the synthesis of cholesterol, disappear and are hardly detectable in the adult brain.

The author then discusses the changes in enzymatic activity which effect a gradual change from one metabolic pattern to an-

other as the "metabolism of growth" in the young is replaced by that of the mature cells in the developing functionally active higher centres. At this stage a metabolic pattern is required which is adapted to the synthesis of the special proteolipids and other complex substances needed for the laying down of myelin to be used for the elaborate system of neurones with large myelinated high-speed axons later developed.

Environmental factors, nutrition, hormones and a sufficient amount of physiological stimulation all play a considerable part in the formation of brain proteins. The author outlines the advances made in the study of brain proteins by means of electrophoresis, which has shown *inter alia* that the proteins present in oedematous areas of the brain show a relative increase in the fast-moving albumin and alpha-globulin fractions. Further, the proportion of fast-moving proteins is higher in the immature infant brain than in the adult brain, and has been found in abnormal amounts in patients suffering from certain forms of epilepsy. In the brains of patients suffering from subacute sclerotizing leucoencephalitis there is a relative increase in the slow-moving gamma-globulin fraction. Some enzymes seem to play a part in the causation of migraine. A number of pathological conditions are now recognised in which the metabolism of the brain is affected by metabolic errors, including such well known examples as phenylketonuria or the "storage" diseases. Imbalance of enzymes may even account for some of the changes occurring in psychotic conditions. More recently, measurements of the rate of uptake of labelled amino-acids by isolated cell particles have thrown light upon the relative metabolic activity of various cell constituents. It has been shown by the autoradiographic method that the rate of incorporation of amino-acids varies in different parts of the brain, and is considerably greater in the grey matter than in the white. It also varies in different conditions; thus it decreases in narcosis, at low temperatures, and during insulin coma. Recent work has suggested that the metabolism of functionally active neurones differs from their metabolism at rest in that there is a preferential utilisation of certain amino-acids.

[This most stimulating review will be read with the greatest interest by those attracted by the wide possibilities for further theoretical and clinical research which have been opened up by the new methods of functional bio-chemistry.]

F. S. Freisinger

Recent Research on Mongolism; the Pathogenic Role of Fluorine

I. RAPAPORT. *Bulletin de l'Académie Nationale de Médicine* May, 1959. **143,** 367-370.

It has been pointed out by several authors that the comparative freedom from caries noted in mongols suggests that the brain and the dental enamel, both derived from the primitive ectoderm, are affected simultaneously by the factor responsible for the pathogenesis of mongolism. The tendency to cataract formation and hyperkeratosis places the disease in Touraine's category of "neuro-ectodermoses" and adds weight to this hypothesis.

Since it has already been demonstrated that fluorine, which increases resistance to caries, can pass through the placenta the author, working at the University of Wisconsin, Madison, has compared the fluorine intake and the incidence of mongolism in towns with a population of 10,000 to 100,000 in the State of Illinois. The fluorine content of the public water supply was determined and each town assigned to one of three groups accordingly. In each group the total number of births in the 7 years 1950-6 was ascertained and also the number of known cases of mongolism occurring in children born during the same period to mothers whose usual place of residence was in one of the towns concerned.

The results were as follows:

Fluorine Content (mg. per litre)	Total Births	Mongols	
		Total	Per 100,000 Births
0 to 0·2	196,186	67	34·15
0·3 to 0·7	70,111	33	47·07
1·0 to 2·6	67,053	48	71·59

It is stated that just as there is no further decrease in the incidence of caries (though there is an increase in mottling) with an increase in fluorine level beyond 1 mg. per litre, so there is a plateau above this level

in the graph of incidence of mongolism. [The statistics are not given in sufficient detail to enable this statement to be confirmed.]

The intake of fluorine in food appears to be fairly constant within the U.S.A., estimates made in three widely separated areas having all given figures of 0·2 to 0·3 mg. per head per day. In Britain on the other hand the average intake of fluorine in food is twice as high, the difference being attributable to the fact that consumption of tea per head of population is 14 times higher in Britain than in the U.S.A., tea containing 160 to 200 mg. F per kg. [or 0·3 to 1·0 mg. per teaspoonful (2 to 5 g.)] of tea leaves. In Britain, therefore, the intake of fluorine—and hence the incidence of mongolism—may be more closely related to the consumption of tea than of water, the fluorine content of which is comparatively low.

The higher incidence of mongolism among the offspring of older mothers could, it is suggested, be explained by the fact that fluorine accumulates progressively in the bones with age and is released into the circulation during pregnancy.

[The author's findings point to many possible lines of research.]

K. W. Todd

Prochlorperazine (Stemetil) in Mental Deficiency

T. L. PILKINGTON. *Journal of Mental Science* Jan., 1959. **105**, 215-219.

From Glenfrith Hospital, Leicester, the author reports a trial of prochlorperazine ('Stemetil') in 28 male and 60 female mentally defectives with severe behaviour disorders. The series included 21 children aged 6 to 14 (average 10·75 years), of whom all but 3 were low-grade defectives. Of the 67 adults, aged 15 to 66 years, 42 were low-grade and 25 high-grade mental defectives. The children received 5 mg. of the drug three times a day for 2 months and the adults initially 12·5 mg. increasing to 25 mg. thrice daily in 2 weeks and continuing at that dosage for the remainder of the 2 months. Improvement in behaviour followed in 57 patients; affective and simple hyperactive patients showed the best response, schizophrenics the poorest, while epileptics were intermediate. Side-effects occurred in only 2 of the children in the form of slight drowsiness and "pins-and-needles". In the adults, however, side-effects were more frequent and disturbing, especially among low-grade defectives. In 20 adults the dosage had to be reduced or treatment stopped because of rigidity and tremor, excessive drowsiness, severe deterioration of behaviour, dizziness, and headaches. Nevertheless prochlorperazine is considered to be of real value in the treatment of severe behaviour disorders in mentally defective patients, especially those belonging to the affective and hyperactive group.

F. K. Taylor

Drug Therapy of Cerebellar Ataxia and Disorders of the Basal Ganglia, Based on Cerebellar-Striatal Antagonism

H. KABAT. *Annals of Internal Medicine* June, 1959, **50**, 1438-1448.

Writing from the Miriam Hospital, Providence, Rhode Island, Dr. Kabat recalls that in an earlier paper [*Arch. Neurol. Psychiat. (Chicago,)* 1955, **74,** 375] he showed that patients with cerebellar ataxia and intention tremor exhibit decreased voluntary isometric muscle contraction while voluntary isotonic contraction (active motion) is relatively unaffected. In contrast, those with lesions of the basal ganglia, such as Parkinsonism, athetosis, and chorea exhibit the opposite type of imbalance. In discussing the opposing clinical effects of lesions of these organs he advances the theory that the cerebellar discharge facilitates voluntary isometric muscular contraction, whereas one of the functions of the basal ganglia is facilitation of voluntary isotonic contraction. From this he argues that drugs (such as reserpine or chlorpromazine) which cause the temporary appearance of Parkinsonian symptoms should relieve the symptoms of cerebellar lesions, while those which induce signs of cerebellar disturbance might relieve those of basal gangliar lesions.

To test this theory, thiopropazate hydrochloride ('Dastal'), which produces Parkinsonian signs in relatively small doses, was given in a dosage of 5 to 88 mg. daily to 23 patients—3 with cerebellar ataxia due to

arteriosclerosis, one with Marie's cerebellar ataxia, one with ataxia following operation on an acoustic neuroma, and 18 suffering from disseminated sclerosis. Improvement in the cerebellar ataxia was obtained in all but 3 of the patients with disseminated sclerosis, of whom 2 showed no benefit and one became worse. The beneficial effects were produced although signs of Parkinsonism might be absent or minimal and appeared promptly after administration of the drug. In a second test, phenytoin, which depresses cerebellar function, was administered in doses of 60 to 300 mg. daily to 7 patients with Parkinsonism, 6 with athetosis, and one with progressive chorea following a head injury. All these patients showed significant improvement in isotonic muscle contraction and in muscle power. The author suggests that these observations support the theory of cerebellar-striatal antagonism.

[Some years ago the abstracter also pointed out that, on theoretical grounds, Parkinsonism should be benefited by inducing a cerebellar lesion. It should be noted that, while the clinical observations in this paper are of interest, the drugs used by the author act primarily on the hypothalamus and reticular formation of the brain stem, so that the assumption that in the cases described they acted specifically on the basal ganglia and cerebellum is not justified; the effects decribed might have been produced by their action on the hypothalamus. This seems somewhat to invalidate the author's deductions.]

R. Wyburn-Mason

Tranquillizers, a Latin Square Trial

M. J. CRAFT. *Journal of Mental Science* April, 1959. **105**, 482-488.

In an investigation at Balderton Hospital, Nottinghamshire, the author attempted to assess the value of drugs in reducing hyperactivity in mental defectives. A total of 18 patients, aged 15 to 44 years, were selected for the trial because of oustanding hyperactivity, aggression, and bad social habits. All the patients had an I.Q. below 34. The trial lasted for 165 days; a preliminary period of 39 days was followed by 6 equal periods of 3 weeks, during each of which one of the following drugs was given: amylobarbitone, amphetamine, promethazine, acetylpromazine, promazine hydrochloride, and prochlorperazine. During the first week of the period the dosage of each drug was progressively increased and during the third week it was progressively decreased. During the second week the daily dosages were: amylobarbitone gr. 6 (0.4 g.), amphetamine sulphate 30 mg.; promethazine hydrochloride 150 mg.; acetylpromazine 150 mg.; promazine hydrochloride 600 mg. (except in 2 instances in which 300 mg. was given); and prochlorperazine 150 mg. The design of the trial ensured that each patient received each drug during one 3-week period, that during any period all 6 patients in any group received a different drug, and that "each drug was followed by every other drug once only in each group".

Behaviour was recorded by nurses (who did not know the nature of the treatment) according to: (*a*) activity, graded from destruction of any article (+6) through normal (0) to stuporose (−6); (*b*) aggression, ranging from injury to others (+6) to injury to self (−6); and (*c*) social behaviour, from spitting and shouting (+6) to eating excreta (−6).

Analysis revealed that in respect of aggression there was no apparent difference between the drugs, although there was a steady increase in aggression throughout the 165 days. The author suggests that this was possibly due to a cumulative effect of the drugs, or to the effect of confinement of the patients indoors, or to a steady change in the standards of judgment of nurses. All the drugs had a "similar small effect" in reducing activity, amylobarbitone and promazine being the least effective. Amphetamine, promethazine, acetylpromazine, and prochlorperazine were found to have a definite residual effect after administration ceased. No significant changes in social behaviour were observed with any of the drugs.

In 6 patients undue sedation with staggering gait was observed with promazine, acetylpromazine, promethazine, and prochlorperazine. Hypotensive episodes occurred in 2 patients given promazine hydrochloride and in 2 given acetylpromazine; 4 patients taking prochlorperazine developed signs of Parkinsonism.

G. de M. Rudolf

NOTICES

Czechoslovak Congress of Paediatric Surgery

Prague, May 23-25, 1960.

The main topics of this congress will be the surgery of the intrathoracic organs and internal injuries (including the C.N.S.). Contributions to one of these themes should be sent before the end of March. Papers on subjects not directly bearing on these topics will also be considered.

The official languages of the congress are Russian, English, Czech and Slovak. There will be a simultaneous interpretation service. Papers should preferably be given in English or Russian. Their length must not exceed 10 minutes. Sessions will be held in the mornings only, with visits to hospitals, specialized institutes etc. in the afternoons. On the evening of May 22 a social gathering will be held and on May 24 a dinner for Congress participants. During the Congress the International Music Festival, "Prague Spring", will be running. A number of hotel rooms will be reserved through the CEDOK Tourist Bureau. The Congress fee is 50 Kcs.

Correspondence should be addressed to the Secretary of the Organizing Committee, Dr. Emil Frynta, at the Department of Paediatric Surgery, Charles University, Prague 2 Ke Karlovu 2, Czechoslovakia.

International Conference on the backward Child

County Hall, London, April 27-29, 1960.

The Guild of Teachers of Backward Children is holding this conference primarily for members of the public health and educational services, care committee organisers, and others responsible for the welfare, training or education of mentally handicapped or backward children. The organiser is Mr. S. S. Segal, of 32 Revell Rise, Plumstead, London, S.E.18.

On the first day speakers from abroad will describe the progress made in their own countries in the education of "E.S.N." pupils and the treatment of the mentally handicapped. On the other two days there will be joint sessions on "discipline and mental health", teacher training, etc., and papers on the severely subnormal, the special school, and the backward child in primary or secondary schools, with special contributions on backwardness and deafness; art and music therapy; educational uses of television; and religion with the backward child. The admission fee is 21s. for all sessions; and anyone wanting help with accommodation should ask Mr. E. Howells, at 6 Elderslie Close, Beckenham, Kent.

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Correspondence should be addressed to the Editorial Board at 28 Fitzroy Square, London, W.1, or to the General Editor at 29 Hadlow Road, Tonbridge, Kent.

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